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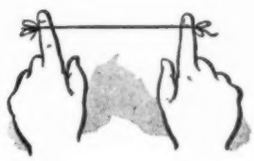

If you tie a string to each index finger, notice that a hard pull will not break the string. This is the action of the hydraulic drive.

If you jerk or snap the string, you can break it easily. This is the action of the non-hydraulic drive.

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July, 1943

THE Petroleum Engineer

VOL. XIV No. 11

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MEMBER A.B.C.—A.B.P. (The articles in *The Petroleum Engineer* are indexed in the *Industrial Arts Index*, New York, N. Y.)

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New valves will be *harder* to get—even if you work directly for the war effort.

There are not sufficient materials for valves—or wear resisting parts. Allocation will reduce, still further, amounts valve manufacturers have been able to obtain for lower ratings. And control is directing the uses to which all valves are shipped.

Too few of us have the feel of this war—yet. But, it is our belief that those who need continued operation of valves will be well advised to adopt conservation and substitution right now—as part of the price loyal citizens pay for a victorious war. It is no whit smarter to try to find "angles" by which materials needed for active war can be diverted to our plants than it is for a commander in the field to withhold an order to fire—to save his own hide.

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The Course of Oil

by K. C. SCLATER

FORESTALLING OIL LOSSES

Almost as much salt water as oil was produced from the East Texas field during May, 1943. Of the total volume of liquid fluid produced during that month, only 53 percent was oil, the remaining 47 percent was salt water. Currently, the actual daily volume of salt water produced with the oil is in excess of 300,000 barrels. Production of salt water in such volume is a serious drain on reservoir pressure and unless checked would lead to an underground loss of oil running into the hundreds of millions of barrels. This volume of water did not appear overnight. It has increased gradually to its present amount over a period of several years.

Curiously enough, the first concern of operators over salt water was its disposal—how to get rid of it without causing steam pollution. Later, as the volume of salt water increased, operators became alarmed over the ensuing drop in reservoir pressure and potential loss in ultimate oil recovery.

A study of reservoir conditions and production data in the East Texas field indicates that failure to take full advantage of the natural water drive in the field could result in an ultimate loss of 300 to 600 million barrels of oil.

Fortunately, the salt water menace is in the process of being eliminated. By voluntary action of the producers themselves, with the full cooperation of the Railroad Commission, the whole problem of salt water in the East Texas field shows promise of a satisfactory and equitable solution. Wells of high water-oil ratio are being shut in and about two-thirds of the volume of salt water produced is returned to the sand. Not only will the life of the field be extended and large underground losses of oil forestalled, but also the salt water disposal problem will be overcome. Eventually, salt water may be returned in such volume that the loss in reservior pressure by salt water production will be negligible.

Based on an input volume of one hundred thousand barrels daily the unit cost of installing salt water disposal facilities on a barrel-per-day basis is estimated to be about twelve dollars. Large volume injection costs are about one and one-half cents per barrel. These are preliminary estimates of costs that are likely to undergo change as experience in the handling of large volumes of salt water in the field is gained. The economic water-oil ratio of production and the related item of efficient rate of salt water injection are important questions that will influence the development of the entire operation.

An important fact is that the handling of salt water in the East Texas field has developed into a problem requiring the voluntary cooperation of the operators for its solution. Operators are desirous of prolonging the life of the field and increasing the ultimate recovery. They are alive to the fact that with the completion of the Big-Inch line and its operation at full capacity, there will be a war demand for East Texas oil probably beyond the efficient capacity of that field to produce.

Details of how the entire salt water problem in the East Texas field is being handled are presented in an article in this issue. The projects described are an encouraging example of enlightened cooperation among operators in reservoir control, and a valuable contribution to the conservation of the nation's oil resources.

AVAILABLE CRUDE PRODUCTION

Evidence continues to pile up that the oil fields of the United States may soon be unable to supply the demands of all military and civilian needs. R. Allen, Assistant Deputy Petroleum Administrator for War, said at the Interstate Compact Quarterly meeting at Pittsburgh, that requirements for the third quarter of 1943 would be four and three-quarter million barrels per day and that the demand would increase in 1944. There is a possibility of a deficit by the end of 1943 of 400,000 barrels a day that could not be produced efficiently from present producing fields of the United States.

An accurate estimate of the available efficient supply of oil from the different oil-producing states is now being made to ascertain how much oil can be produced efficiently without running the risk of creating physical waste and reducing further the present oil reserves of the nation.

The Cost and Price Adjustment Committee of the Petroleum Industry War Council, asserts that the demand for petroleum in the near future may exceed the currently available maximum efficient supply, necessitating resort to wasteful production. In regard to costs, this Committee concludes that because of increases in virtually all the items of cost in the search for and development of reserves, and especially because of the increasing effort required to achieve any given volume of discovery, the capital costs of crude-oil properties and the operating costs of producing crude yet to be discovered will be measurably higher than the costs that attach to the reserves heretofore discovered and developed.

So far this year, wildcat drilling has fallen far short of the number of wells suggested by the Director of Production of the Petroleum Administrator for War. As is well known, the industry is confronted with an inadequate crude price, lack of steel, too many governmental restrictions on drilling, and manpower problems. Any relief the industry is likely to receive may come too late.

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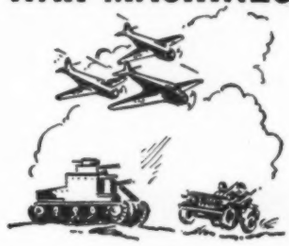

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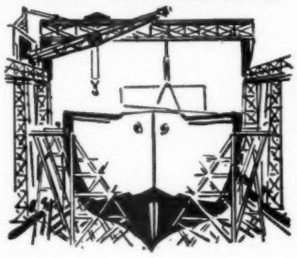

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Highlights IN OILDOM

House Committee Completes Hearings

The House Naval Affairs Committee, after completing a series of hearings in the oil-producing areas, has returned to Washington prepared to aid in clarifying the muddled oil picture. Members of the committee, consisting of Congressmen Mandell Rivers of South Carolina, R. Herbert of Louisiana, W. H. Wheat of Illinois, and G. J. Bates of Massachusetts, all expressed confidence in the solidarity of the oil industry, but expressed the view that an ill-advised group of officials did not hold the same view.

Hearings were held at Decatur, Illinois, El Dorado, Arkansas, Jackson, Mississippi, Dallas, Texas, and New Orleans, Louisiana. At these hearings approximately 70 oil executives testified to the present status of the industry, and the committee talked informally to more than 300 others.

Although testimony taken in the several states differed regarding the relative responsibility of price, manpower, and material factors in retarding exploration, opinions were much the same on the following points:

1. A crude oil shortage is certain unless exploration is encouraged immediately.
2. Current oil requirements are being met largely from fields that were discovered 5 to 20 years ago.
3. The price of crude oil should be raised at least 50 cents a bbl. as the surest way to encourage wildcatting.
4. Materials as well as labor must be found to enable the industry to maintain present production and to meet new demands for war and essential civilian use.
5. Red tape of governmental agencies must be relaxed to permit less delay on applications.
6. Texas and Louisiana could produce from 250,000 to 300,000 bbl. a day additional oil if transportation could be provided.
7. In general, witnesses listed prices first, then materials, then manpower as the prime factors now preventing extensive wildcatting.

Captain Robert L. Graham, U.S.N., acted as legal advisor to the committee at all hearings.

Interstate Oil Compact Renewed

President Roosevelt, on July 7, signed the Senate-House resolution extending to four years beyond September 1 the consent of Congress for the operation of the Interstate Oil Compact Commission. At a recent meeting of the Commission in Pittsburgh, Pennsylvania, at which 11 of the 13 member states were represented, renewal of the compact for an additional four years was signed.

At that meeting two resolutions were adopted, one calling attention of Congress and the price control authorities of the government to the impending shortage of oil and asserting that petroleum conservation is in serious jeopardy through lack of incentive for wildcatting. The other resolution asked state regulatory bodies to determine the maximum efficient rate of production of oil fields within their borders and to pass the result of their findings on to governmental authorities.

Assignment Deputy PAW Allen told the meeting that estimated petroleum requirements for the United States, third quarter, were 4,750,000 bbl. daily and the supply is 4,360,000 bbl. He pointed out that there were only three methods of making up the deficit: withdrawal from storage, drastic cutting of civilian supplies, by drawing on foreign supplies.

Dr. Robert E. Wilson, chairman of PIWC committee on economics, urged that production be adjusted to the most efficient rate immediately. Post war re-adjustments were discussed by Dr. Alexander Sachs, Lehman Corporation, and economic advisor to PIWC. Dr. John Gill, Atlantic Refining Company, spoke on crude oil prices and conservation. In his talk B. H. Weil, Gulf Research and Development Company, dealt with shale oil and other petroleum substitutes and showed that their high cost put them out of reach at present.

Refiners Advised to Make Needs Known

Refiners are advised by Frank A. Watts, director of materials, Washington, D. C., to make known their needs for the first quarter of 1944. In a statement he says:

"1. Anticipate your needs for the first quarters of 1944 for MRO Controlled Materials in the form of still tubes, pipe, and heat exchanger tubes. These are to include carbon steel, alloy (including stainless) steel, as well as copper and copper base alloys.

"2. Submit requirements in the form of purchase orders to PAW, Washington, D. C., immediately in order to receive approval with the least possible delay.

"3. Submit sustantiating data with orders justifying quantities requested. State present inventory, amount on order, average quarterly usage, and anticipated usage for the first quarter of 1944."

Salt Water Injection Increases

Increased salt water injections in the East Texas oil field have boosted bonus oil allowables another 240.25 bbl. daily, and transfer of allowables from the leases on which they were earned to other leases has reached a record peak.

The Texas Railroad Commission announced that June allowables of 173 East Texas wells have been raised 364.33 bbl. daily as credit for increased brine return from those wells. Allowables of 67 wells were reduced a total of 124.08 bbl. daily, leaving a net gain of 240.25 bbl.

Most bonus allowables are transferred to leases where salt water production is nonexistent or negligible. June transfers totaled 3527.54 bbl., the commission reported. Forty-nine major oil companies and independent operators participated.

Operators are allowed 1 bbl. extra oil production for each 50 bbl. of their salt water production injected.

New Body to Search for Oil Outside U. S.

Jesse H. Jones, Secretary of Commerce and head of the Reconstruction Finance Corporation, has announced the creation of the Petroleum Reserves Corporation as a subsidiary of RFC for the purpose of acquiring petroleum, petroleum products, and petroleum reserves outside the continental United States. The corporation was created at the direction of the President.

"While no definite plans have been formulated," Jones announced, "consideration is being given to one or two subjects that may be of value to the war effort. The objective is to look ahead, in the unfortunate event of a prolonged war."

This brief announcement from Secretary Jones gave rise to speculation regarding the probable extent and purpose of the new corporation's activities. It was recalled that Secretary of the Navy Frank Knox recently predicted that crude oil supply would be seriously short within a year and would be exhausted within 15 to 20 years insofar as the currently known reserves in this country are concerned.

The United States is developing a new crude oil source at Fort Norman in northern Canada, and it is regarded as likely that developments of similar projects in other countries may be contemplated, such projects to be financed through the newly formed corporation. South America, Africa, and the Near East are regarded as likely areas for such developments.

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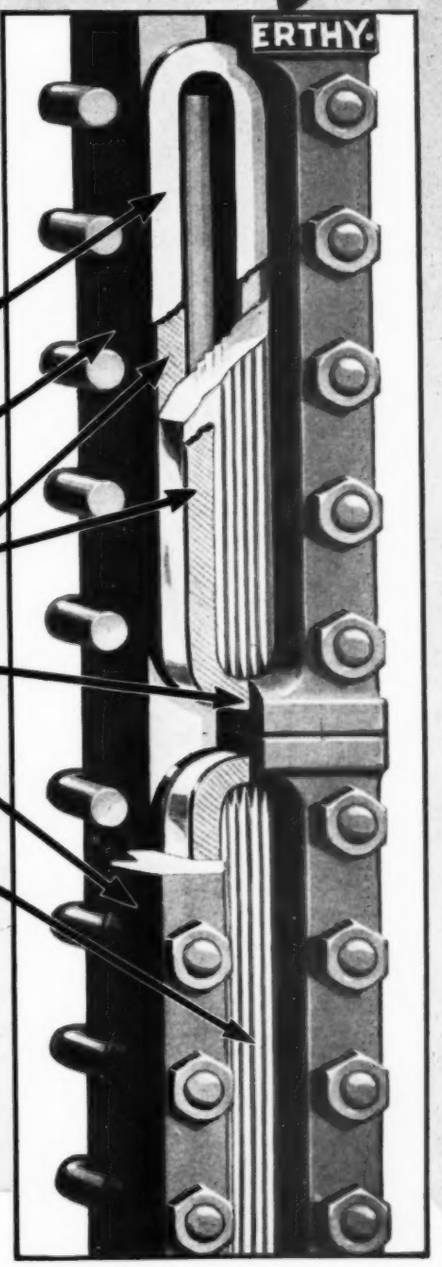

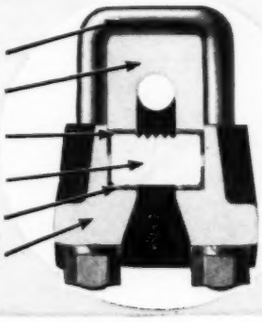

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MAJOR *Refining* ACTIVITIES

A REMARKABLE wartime refinery is being built in southern Oklahoma as fast as the materials of construction can be delivered and skilled workmen can put them together.

This plant is chiefly remarkable for two reasons: It is the first refinery in Oklahoma built entirely for war production and equipped to produce all the components of 100-octane gasoline, blend them together and ship out finished fighting aviation motor fuel. Second, it represents the joint determination of eight prominent, independent Oklahoma and Texas refineries to join their resources, their skill and their ingenuity in a common effort to achieve greater effectiveness in war production for Uncle Sam than any of them could do alone.

These refiners are Anderson-Prichard Company, Bell Oil and Gas Company, Ben Franklin Refining Company, Cosco Oil Company, La Salle Petroleum Corporation, Panhandle Refining Company, Rock Island Refining Company, and W. T. Waggoner Estate.

They have organized a new company, Associated Refineries, Inc., to build and operate the war products refinery. M. Lloyd Freese of Bell Oil and Gas Company is president and general manager of Associated Refineries. L. B. Simmons, president of Rock Island Refining Company, is chairman of the board. Other directors are: B. I. Lubell, R. V. Anderson, J. S. Cosden, Jr., L. H. Prichard, R. C. Stanford, P. D. Williams, and H. B. Alspaugh.

The eight refiners are making certain necessary changes and revamping certain equipment in their individual refineries in order to fulfill their parts in the contract to contribute certain raw materials to the Associated Refineries plant. They will continue operation of their refineries throughout the war, thus assuring that there will be no disturbance of crude oil connections or refinery operations in southern Oklahoma and north Texas.

Cost of the Associated refinery will be about $10,000,000. The catalytic units for the production of aviation gasoline were designed by Universal Oil Products Company and will be operated under license from Universal. Defense Plant Corporation is financing the plant by and through Associated Refineries, Inc. The contract for its construction has been let to the Frick-Reid Supply Corporation. Exact details of the processes to be used, operating data and plant facilities cannot be disclosed. Some general description is permitted, however. One of the interesting features is a fluid-flow catalytic cracking unit, similar to those recently installed in the Bayway refinery of the Standard Oil Company of New Jersey and the Baton Rouge refinery of the Standard Oil Company of Louisiana. Three of these units are in commercial operation producing high yields of aviation gasoline, and a number of others are under construction throughout the country. The Associated unit is about 200 ft. high, equal to a 20-story office building. Other catalytic units are an HF alkylation unit and an isomerization unit.

Officials of The Dow Chemical Company have announced that full scale production was achieved six weeks ahead of schedule in the first unit of its new styrene plant in Los Angeles, California. This plant is part of three manufacturing units of the synthetic rubber project. The second plant unit is being operated by the Shell Oil Company, which supplies the other major ingredient, butadiene. The third unit, for the copolymerization process, is being carried out by the Goodyear and Firestone rubber companies. By locating these three plants side by side, production is expedited by enabling Dow and Shell to pump styrene and butadiene, respectively, from their production units to the Goodyear plant where these ingredients are transformed into crude synthetic crepe rubber, which is later melted, compounded, and fabricated into finished rubber products.

High praise is due plant design engineers and the construction company charged with the erection of the project for the speed in carrying this plant from plans to full fledged production. This $15,000,000 unit was erected in less than 10 months. The original design for the plant involved two units and completion of the first unit with production at near capacity is a result of careful engineering and the long experience of Dow production men in complex mechanical and chemical problems.

Phillips Petroleum Company has just completed construction and begun operation of the company's ninth plant making aviation gasoline constituents for the Allied Air Forces. This completion marks an important stage in the government's aviation gasoline program. The plant was authorized and started, along with many others, at the time President Roosevelt announced that U. S. airplane production would exceed 75,000 per year, and now the plant is beginning to turn out the fuel that these planes will use. Phillips Petroleum Company was one of the first and is one of the largest suppliers of high octane aviation gasoline to the country's air forces, six of the nine aviation gasoline ingredient plants being in operation before Pearl Harbor.

The new plant uses the recently developed HF alkylation process and is the second plant to be completed that uses this improved process. The first HF alkylation plant was also built by Phillips Petroleum Company and was put into operation last year. The fact that the alkylate produced in these two plants will make several times as much 100-octane aviation gasoline as was being used by the U. S. Air Forces immediately before World War II indicates the tremendous expansion that has been accomplished in the production of aviation gasoline.

Location of the plant or estimates of its capacity cannot be revealed.

Crude Runs to Stills, Production[1] and Stocks[2] of Motor Fuels
Week Ended June 26, 1943
A.P.I. Figures
(Figures in thousands of bbl. 42 gal. each)

DISTRICT	DAILY REFINING CAPACITY Potential Rate	DAILY REFINING CAPACITY Percent Reporting	CRUDE RUNS TO STILLS[3] Daily Average	CRUDE RUNS TO STILLS[3] Percent Operated	Total Production	Total Stocks
*Combined: East Coast, Texas Gulf, Louisiana Gulf, North Louisiana-Arkansas and Inland Texas	2,444	88.7	1,899	77.7	11,662	62,409
Appalachian	177	84.8	153	86.4	843	4,381
Ind., Ill., Ky.	824	85.2	747	90.7	4,402	26,385
Okla., Kans., Mo.	416	80.1	360	86.5	2,283	10,364
Rocky Mountain	147	55.9	104	70.7	602	2,882
California	817	89.9	752	92.0	4,790	82,960
TOTAL U. S.—B. OF M. BASIS JUNE 26, 1943	4,825	86.4	4,015	83.2	24,582	189,381
TOTAL U. S.—B. OF M. BASIS JUNE 19, 1943	4,825	86.4	3,905	80.9	24,736	188,191
U. S. B. OF M. BASIS JUNE 27, 1942			3,597		21,899	207,812

*At the request of the Petroleum Administration for War.
[1]Production—total of gasoline at refineries including natural and blended; kerosine, gas oil and distillate fuel oil, and residual fuel oil.
[2]Stocks—at refineries, bulk terminals, in transit, and pipe lines of finished and unfinished gasoline; kerosine, gas oil and distillate fuel, and residual fuel oil.
[3]Figures on production and stock include reported totals plus an estimate of unreported amounts and are therefore on a Bureau of Mines basis.

NO. 7 OF A SERIES

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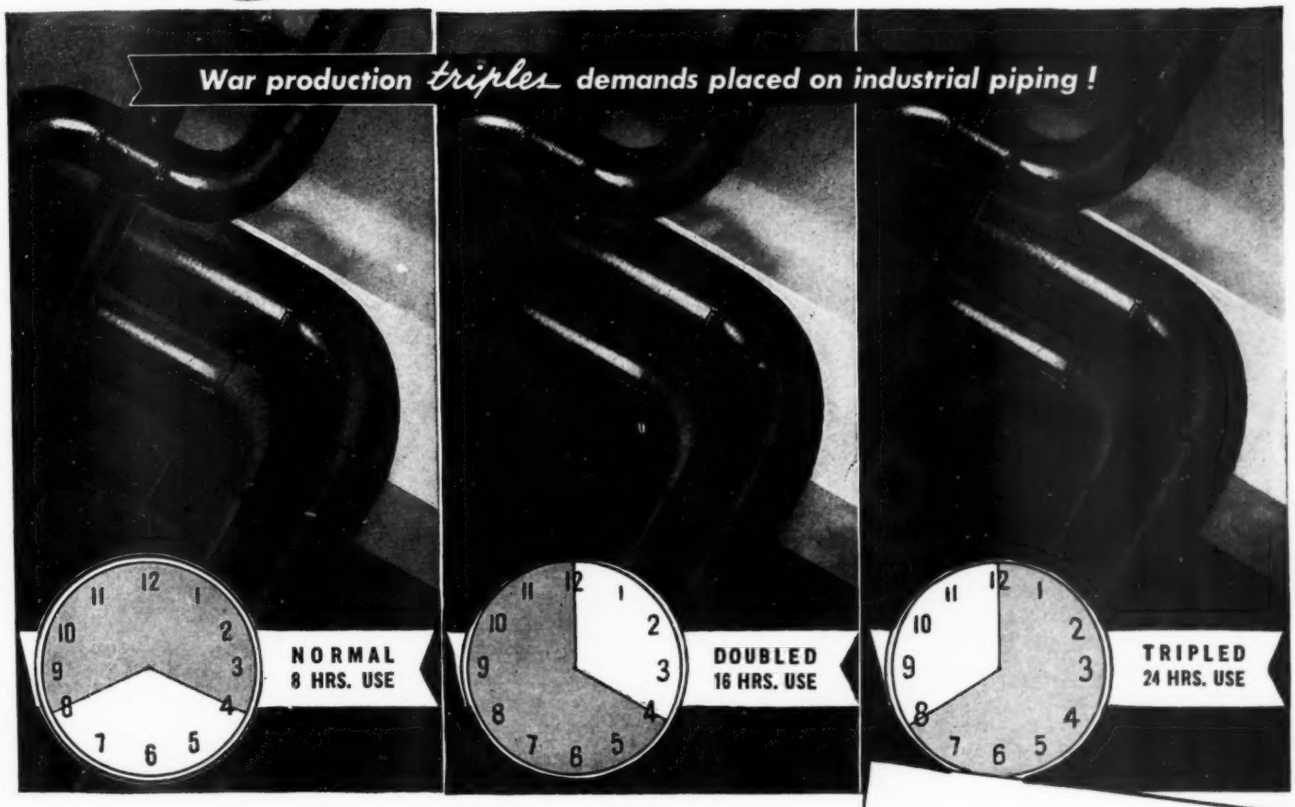

'ROUND the clock, war-time operation for 24 hours a day instead of the normal 8 hours period *triples* the wear of oil, gas, power, chemical, heating, air, refrigeration and marine piping today.

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LAST LONGER: Smooth inner walls—with no ridges, waves or scale—means less corrosion and longer life.

LESS PRESSURE LOSS: Because of full effective radius and exact O.D. and I.D. alignment with the pipe, the flow is more efficient and pressure loss is less.

FEWER SUPPORTS NEEDED: Since welded piping weighs less and stands vibration better than flanged systems, few hangers or supports are required.

TUBE-TURN

TRADE MARK

Welding Fittings and Flanges

TUBE TURNS (Inc.), Louisville, Ky. *Branch offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, Los Angeles. *Distributors in principal cities.*

MAJOR *Oil Field* ACTIVITIES

▶ **Texas.** A wildcat well having two pay zones is the Henderson Coquat No. 1 Goebels, two miles northeast of Oakville in Live Oak County. The first flow was through perforations at 6972-82 ft. and gauged 120 bbl. a day. The second zone is at a depth of 7081-84 ft. and gauged 220 bbl. of oil and more than 2,000,000 ft. of gas daily.

▶ **Kentucky.** Three new oil pools in 10 days is the record made by Carter Oil Company. In Union County, the company's No. 1 Russelburg filled 1300 ft. with oil in two hours on a drill-stem test. Total depth is 1712 ft. in the Walterburg sand. Another Walterburg sand pool opener is the No. 1 Cottingham in Henderson County. With depth of 1806 ft., 143 bbl. of oil and no water was swabbed in 14 hours. The third Carter discovery, also in Henderson County, had 1450 ft. of oil and 90 ft. of oil-cut mud on a drill-stem test in two hours. In the McCloskey lime, the hole has a total depth of 2506 ft.

▶ **Louisiana.** Discovery of oil in the E. R. Brann No. 1 Edgewood Land Company, 6-8s-10w, opens up the Perkins area of Calcasieu Parish. Drilled to 5006 ft. in the Frio sand, the well produced 156 bbl. a day.

▶ **Oklahoma.** A Cleveland County pool opener, Deep Rock Oil Corporation, Selby Oil and Gas Company, and Lewis Production Company No. 1 Harris, NE NW NE 11-10-1w, after being cased and acidized flowed at the rate of 25 bbl. an hour. The Simpson sand discovery well was perforated at 6492-507 ft.

▶ **Texas.** Official test of the Ben F. Reed, trustee, No. 1 Corbett, showed production of 35 bbl. an hour of 43.8 gravity oil through 2-in. tubing for a potential of 840 bbl. The wildcat opened a Lake sand pool in Stephens County.

▶ **Kansas.** Ellis County has a new pool opened by Nate Appleman and Company No. 1 Richards, CSE SE 19-11-18w, four miles south of the Richards pool. The well has been assigned a potential of 1332 bbl. from the Arbuckle at 3610-19 ft.

▶ **Louisiana.** A new sand discovery in the West Bay field, Plaquemines Parish, is Gulf Refining Company No. 5 State-West Bay. Final gauge showed 234 bbl. of oil daily from 10,765-68 ft. Previously the well was tested at 10,771-777 ft., flowing 497 bbl. daily through 1/8-in. choke but water encroachment forced a test higher up.

▶ **New Mexico.** Lea and Eddy counties each boasts a new pool. Maljamar Oil and Gas Company No. 2 Cheesman, C NW NW 22-18s-32e, three miles southeast of the Maljamar pool in Lea, swabbed 27 bbl. of oil through casing after shooting a lower pay zone with 90 quarts from 4771-90 ft. In Eddy County a Delaware sand at 2638-44 ft. logged a showing of oil in the Schuster and Messinger No. 1 Page, C NW SW 15-21s-28e.

▶ **Oklahoma.** The new wildcat north of the Dill area, in Okfuskee County, No. 1 Turner Community, NE NW NE 24-12-8e, flowed 100 bbl. an hour when tested. In the Cromwell sand, the Mid-Continent Oil Corporation producer is drilled to 3504 ft.

▶ **Oklahoma.** Stanolind Oil and Gas Company has discovered a new pool with its No. 1 Perkins, SWC 10-8-3, Pottawatomie County. The well flowed 340 bbl. of oil in 24 hours through perforations in casing between 4855-75 ft. The hole was drilled to a total depth of 5474 ft. in the Wilcox sand, which was dry. Treatment with 1000 gal. of acid through perforations in the Hunton lime brought the flow.

AVERAGE CRUDE OIL PRICES

California		Louisiana	
Kettleman Hills	$1.23-1.29	Rodessa	$ .88-1.20
Playa Del Rey	.80- .87	Gulf Coast	.93-1.36
Coalinga	.73-1.13	North Louisiana	.98-1.30
Wilmington	.68-1.24		
Montana	1.00-1.15	Illinois	1.22-1.37
Wyoming	.45-1.15	Kentucky	1.32-1.43
Colorado	1.05-1.07	Indiana	.85-1.25
New Mexico	.70-1.15	Ohio	
Texas		Lima	1.50-1.60
North Central	.97-1.25	Michigan	1.24-1.44
Panhandle	.70-1.12	Pennsylvania	
West Texas	.80-1.27	Bradford	3.00
Gulf Coast	.93-1.48	Southwest	2.65
Darst Creek	1.14	Eureka	2.59
East Texas	.80-1.27	Buckeye	2.30
Talco	.79	Corning	1.31
Kansas	.93-1.25		
Oklahoma	.75-1.25		
Arkansas	.94-1.36		

DAILY AVERAGE CRUDE OIL PRODUCTION

Data Supplied by A.P.I.

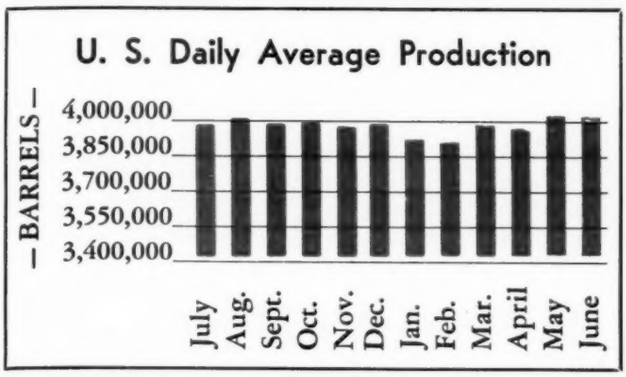
(Figures in bbl. of 42 gal. each)

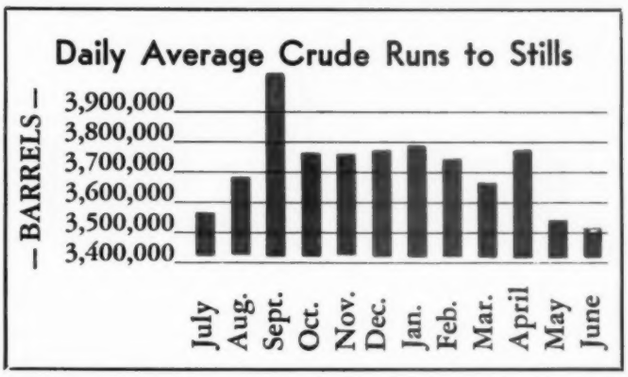
	[1]P.A.W. Recommendations June	Week Ended June 26, 1943	Week Ended May 29, 1943	Week Ended June 27, 1942
Oklahoma	373,500	[2]339,450	323,250	369,300
Kansas	300,000	[2]306,950	299,450	272,100
Nebraska	2,400	[2] 2,200	2,050	3,750
Panhandle Texas		90,100	91,100	107,000
North Texas		131,800	131,750	149,400
West Texas		228,950	226,750	234,450
East Central Texas		123,500	124,300	94,050
East Texas		334,900	339,300	295,000
Southwest Texas		208,250	214,000	163,600
Coastal Texas		380,200	375,200	280,800
TOTAL TEXAS	1,602,000	1,497,700	1,502,400	1,324,300
North Louisiana		84,700	87,050	90,700
Coastal Louisiana		240,850	261,050	220,000
TOTAL LA.	330,800	325,550	348,100	310,700
Arkansas	72,800	75,150	72,900	73,700
Mississippi	50,000	53,100	54,000	83,500
Illinois	246,200	207,750	211,550	274,900
Indiana	15,500	14,500	13,650	18,650
Eastern (Not incl. Ill., Ind., Ky.)	88,400	76,950	79,700	86,650
Kentucky	23,100	19,800	21,950	11,800
Michigan	58,900	54,400	61,700	65,700
Wyoming	97,000	92,000	92,100	92,150
Montana	22,300	20,850	20,900	22,350
Colorado	7,000	6,900	6,650	7,450
New Mexico	105,700	97,150	96,850	65,150
TOTAL EAST OF CALIF.	3,395,600	3,190,400	3,207,200	3,082,150
California	823,300	764,500	763,100	637,300
TOTAL U. S.	4,218,900	3,954,900	3,970,300	3,719,450

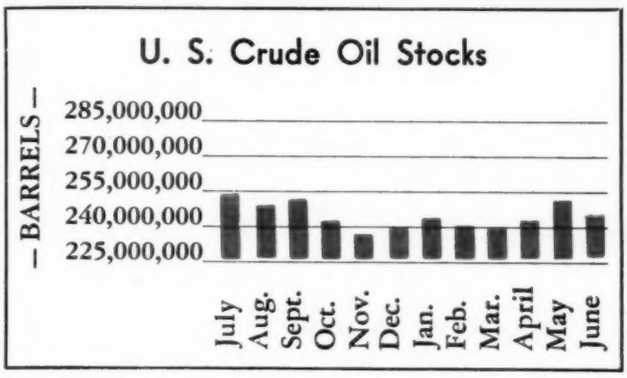
[1]P.A.W. recommendations and state allowables represent the production of all petroleum liquids, including crude oil, condensate and natural gas derivatives recovered from oil, condensate and gas fields. Past records of production indicate, however, that certain wells may be incapable of producing the allowables granted, or may be limited by pipeline proration. Actual state production would, under such conditions, prove to be less than the allowables. The Bureau of Mines reported the daily average production of natural gasoline and allied products in March, 1943, as follows: Oklahoma, 27,700; Kansas, 5,600; Texas, 105,800; Louisiana, 20,400; Arkansas, 2,500; Illinois, 10,600; Eastern (not including Illinois, Indiana or Kentucky), 9,700; Kentucky, 3,500; Michigan, 100; Wyoming, 2,200; Montana, 300; New Mexico, 5,500; California, 43,400.

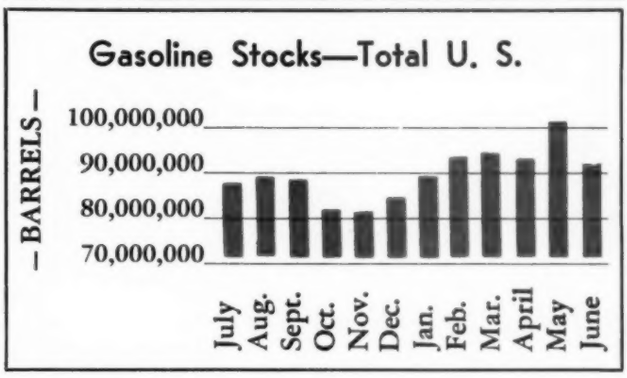
[2]Oklahoma, Kansas, and Nebraska figures are for week ended 7 a. m., June 24, 1943.

PETROLEUM *Statistics* AND FIELD *Operations*









Above statistics by American Petroleum Institute.

Summarized Operations in Active Fields for June, 1943

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
Eastern Texas	18	15	6	....	3500-3700	2	40	Rotary
Gaines County	3	2	5	....	4400-5584	2	22-35	Rotary
Hockley County	7	5	3	....	4800-6850	2	20-30	Rotary
Ector County	4	3	5	....	3675-4377	2 or 3	32-36	Rotary
Panhandle	11	8	4	....	1700-3900	2	40	Rot.-Cab.
Nueces County	6	4	6	....	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	3	2	4	....	3730-2935	2	42-43	Rot.-Cab.
Hawkins Field	2	2	4	....	4495-4912	2	19-29	Rotary
OKLAHOMA								
Okfuskee County	5	4	6	....	2150-4125	2 or 3	38	Rotary
KANSAS								
Russell County	6	3	5	....	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	8	6	5	....	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	3	1	3	....	3290-3518	2	39-42	Rot.-Cab.
ILLINOIS								
Central Illinois	150	105	27	115	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	7	5	6	....	3150-4030	2	30-34	Rot.-Cab.
CALIFORNIA								
Kern County	4	2	5	....	1840-11,450	3 or 4	14-30	Rotary
Wilmington County	4	3	4	....	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for June, 1943

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1942 (In Barrels)
	June	May	June	May	June	May	June	May	June	May	
Arkansas	18	22	16	15	12	14	9	8	20	18	26,560,000
California	97	103	88	87	42	11	39	28	51	28	248,250,000
Illinois	150	138	105	118	56	37	27	66	115	124	105,768,000
Indiana	10	20	7	8	21	9	5	6	10	3	6,680,000
Kansas	97	120	81	81	37	43	18	12	15	19	96,920,000
Kentucky	23	18	18	14	12	9	....	....	....	....	4,503,000
Louisiana	90	122	77	93	47	28	12	10	28	29	125,450,000
Michigan	40	33	31	24	18	5	13	9	19	....	21,568,000
Mississippi	5	....	3	....	....	....	....	....	....	....	27,605,000
Montana	20	3	15	2	....	....	6	....	....	....	8,998,000
Nebraska	....	....	....	....	7	1	....	....	....	....	1,367,000
New Mexico	25	23	20	16	14	11	....	....	....	....	31,875,000
New York	101*	88*	85*	73*	56	43	27	....	....	....	5,132,000
Ohio	74	63	67	51	35	47	22	....	....	....	3,480,000
Oklahoma	107	97	92	76	29	15	20	11	61	58	138,750,000
Pennsylvania	192*	177*	89*	158*	108	118	....	....	....	....	17,256,000
Texas	291	311	231	211	298	261	250	279	291	198	476,560,000
West Virginia	45	36	32	25	19	14	4	8	21	11	3,780,000
Wyoming	10	12	8	....	6	3	2	....	19	....	32,778,000
Total	1395	1386	1065	1052	817	669	454	437	650	488	1,383,280,000

*Includes water-intake and pressure wells.

MAJOR *Pipe Line* ACTIVITIES

WORK has begun on extension of Panhandle Eastern Pipe Line Company's facilities from the Amarillo, Texas, gas fields to Kansas City, Missouri. The additions will increase deliveries by 90,000,000 cu. ft. a day, it is stated. The construction contract calls for 120 miles of 26-in. loops and the relaying of 35 miles of 22-in. line paralleling the company's main line from Moore County, Texas, to Kansas City. Completion of the work is scheduled for early fall.

The construction contract was awarded to three contractors who pooled their resources for the job. They are: The Bechtel Company, San Francisco, California, O. E. Dempsey Construction Company, Tulsa, Oklahoma, and H. C. Price Company, Bartlesville, Oklahoma.

The first pipe line outlet for the new Quitman Paluxy sand field of north Wood County, Texas, has been authorized by the War Production Board. The 35-mile line of 4½-in. pipe will be constructed by the Central Pipe Line Company of Hawkins, running from the firm's pump station at Big Sandy to the pool.

The Central organization recently purchased the 60-mile 8-in. pipe line and gathering system of Rogers Lacy at Longview, Texas, that runs from the Hawkins field to Gladewater. It is planned to run the Quitman field oil to Big Sandy, where it will connect with the Hawkins line and then be transported to Central East Texas.

To make it unnecessary to mix the Hawkins and Quitman crudes, the company's purchases will hereafter be moved by tank car to destinations. A loading rack on the Texas and Pacific Railroad is under construction at Big Sandy for this purpose.

Consideration is being given a proposal to build a second pump station on the 383-mile 16-in. pipe line from Sundown, West Texas, to Drumright, Oklahoma. If approved the additional station will increase the capacity of the line to 65,000 bbl. or more daily. Capacity of the line as planned at present is 54,000 bbl. daily.

Stanolind Pipe Line Company has already ordered the 44,600 tons of steel pipe that is required. The line will connect with the present Texas-Chicago artery in Drumright and carry crude oil to Great Lake refineries.

The Office of War Information has announced that 473 barges, 100 tugboats, and 21 river towboats are expected to be in operation by the end of 1943, carrying oil from Texas gulf ports to Eastern terminals via the Mississippi River and intracoastal waterways. The program is sponsored by the Office of Defense Transportation, financed by the Defense Plant Corporation, and carried out with the coöperation of the Petroleum Administration for War.

Two routes will be used by the barges, one through the gulf intracoastal waterway from Texas oil fields to Panama City, Florida, where the oil will be shipped across Florida by tank car to Jacksonville, and thence by barge along the Atlantic intracoastal waterway to Eastern oil distribution ports. The other route is up the Mississippi River by barge tow for transshipment by rail.

Hope Natural Gas Company of Clarksburg, West Virginia, has applied for permission to construct and operate a 22-in. natural gas pipe line from Southern Kansas to Kanawha County, West Virginia. The line would be built at an estimated cost of $50,904,711 and would be approximately 1140 miles long. Application is filed with Federal Power Commission.

China is using on a large scale one of its most ancient forms of transportation to bring petroleum products to points where they are needed. This is the goatskin method. The first considerable attempt to put the "Goatskin Express" into operation was when 1000 inflated goatskins carrying 31½ tons of petroleum products were floated from Shenshi to Chungking. The skins were divided into three large rafts and guided to their destination. After being emptied, they were deflated and returned to their starting point by land. The rafts were floated on the Chialing, which flows into the Yangtze. The operation was handled by the Kansu Oil Company and was said to be far cheaper than transportation by truck. Drawing less than a foot of water, the rafts carried their 168 bbl. of petroleum products through the swift and often shallow stream.

Last of the 24-in. steel pipe for the "Big Inch" has gone to its destination and crews of pipe line companies are laying the last leg from Norris City, Illinois, to Phoenixville, Pennsylvania.

U. S. Steel Corporation subsidiaries claim a record for the National Tube Company, Lorain, Ohio, in the production of the 280,106 tons of seamless steel pipe since last July for the 1272-mile crude oil pipe line from Texas to the East Coast. The "Big Inch" will have a capacity of 300,000 bbl. of oil daily.

The manufacturer states that on many occasions the 41-ft. steel pipe sections were turned out at a speed of six miles a day, or enough to load a train of 45 cars.

National Tube workmen now have turned their entire efforts to producing pipe for the 20-in. oil products line, known as the "Big Little Inch," which is being laid alongside the larger pipe line.

Sinclair Refining Company's products pipe line has been extended by the Washington part of the Baltimore-Washington artery. The new line is temporarily receiving traffic from Sinclair's Marcus Hook, Pennsylvania, refinery. Capacity of the pipe line is 12,000 bbl. a day. The Washington-Baltimore artery is a section of the pipe line that will eventually receive deliveries from the Steubenville, Ohio, terminal on the Ohio River after barges have made deliveries at that point from Middle West and Southwest refineries. This section ties into the main line at Mechanicsville, Pennsylvania, and is fitted to make deliveries at 19 other bulk stations along the right-of-way.

Need of two additional pipe lines from the Permian Basin area in West Texas was urged by Chairman Jester of the Texas Railroad Commission before the House Naval Affairs Committee, meeting in Dallas. One would terminate at Minneapolis or Chicago and the other at the California coast line. At the same time H. P. Nichols of Tyler, executive vice-president of the East Texas Oil and Gas Association, presented a recommendation for a new pipe line from West Texas to the St. Louis area.

When the house members were at Jackson, Mississippi, they held a two-day hearing on the question of whether the Tinsley field will justify construction of a pipe line to terminals at Charleston, South Carolina, and Savannah, Georgia.

Talco Asphalt and Refining Company has completed a new 6-in. pipe line, 35 miles long, connecting the Coke field, in northern Wood County, Texas, with its refinery at Mount Pleasant, Texas. The pipe line connects with a field gathering system completed earlier by the company.

P 501.61

THE Petroleum Engineer

JULY, 1943

Subsurface Disposal of Salt Water In the East Texas Field*

PETROLEUM ENGINEER Exclusive

☆ Project now comprises 56 injection wells, which have returned to the producing zone in excess of 87,000,000 bbl.

by W. S. Morris

Vice-President and General Manager, East Texas Salt Water Disposal Company

AS early as 1935, operators in the East Texas field realized that the disposal of salt water was a problem of increasing importance. At that time the field was producing approximately 15,000 bbl. of salt water per day, but it was apparent to students of water drive fields that the volume of salt water would greatly increase from that time forward. The disposal of salt water by means of evaporation, storage in surface pits or release into surface streams were all found to be unsatisfactory methods at an early date.[1] Because of the relatively high porosity and permeability of the Woodbine sand, the possibility of returning the water to the Woodbine reservoir below the oil interface was attractive not only as a means of disposing of the salt water, but also for pressure maintenance in the field.

A group of East Texas operators experimented with the idea of returning salt water to the Woodbine sand through an abandoned oil well located approximately two miles west of production in the southern part of the field early in 1936.[2] The results of this experimental work encouraged operators to investigate further the possibilities. The first salt water disposal system in the field was put into operation by the Sun Oil Company on its H. A. Pace "B" lease in the Vargas Survey of Smith County in June, 1938. From this beginning, 56 salt water disposal systems are now in operation in the field and have returned to the Woodbine sand a volume of salt water in excess of 87,000,000 bbl. (See Table 1.)

W. S. MORRIS

was graduated from University of North Carolina in 1924, receiving B.S. and C.E. degrees—Was junior engineer with Empire Gas and Fuel Company, 1924 to 1926—Petroleum engineer U. S. Bureau of Mines, Bartlesville, Oklahoma, 1926 to 1929—From 1929 to 1936, was a petroleum engineer for the Indian Territory Illuminating Oil Company—Was admitted to the Oklahoma Bar in 1936—Was field chairman for the East Texas Engineering Association from 1936 to 1942—Served as chairman of the Southwestern District A.P.I., in 1938—Founded the Petroleum Division of the East Texas Section of the A.I.M.E. and was first chairman—September, 1942, was appointed by the East Texas Salt Water Disposal Company to present position.

Salt Water Production

Although the production of approximately 15,000 bbl. of salt water per day in October, 1935, was disturbing to some operators in the field at that time, it was not until the latter part of 1938 when the volume exceeded 100,000 bbl. per day that the problem was considered one of real importance. By the end of 1939, salt water production had reached approximately 200,000 bbl. per day and by the middle of 1941 had exceeded 400,000 bbl. per day. The increase in the number of wells producing salt water and the volume of water produced (in a "producing day") from 1934 through 1942 is

*An informal discussion of salt water disposal in East Texas was given by the writer before the Petroleum Division of the A.I.M.E. at the Dallas, Texas, meeting in May.

[1]References at end of paper.

shown in Fig. 2. It will be observed that the increase in water production was so rapid that the curve had to be plotted on a logarithmic scale.

Since November, 1937, the East Texas field has been subjected to various numbers of shut-down days each month. Wells below the marginal producing rate of 20 bbl. per day are permitted to produce every day in the month, whereas wells whose oil allowables are greater than 20 bbl. are restricted by the number of shut-down days in effect. Therefore, to determine the volume of water produced in any month, the salt water produced by the marginal wells is multiplied by the number of calendar days in the month to which is added the volume of water produced by the proratable wells times the number of producing days allowed during the month.

From the map in Fig. 1, the degree of salt water encroachment on the west side of the East Texas field may be readily observed. West side wells from one end of the field to the other produce salt water, but the degree of encroachment in any area is very irregular and has no particular relation to the adjoining area; for example, there is a nose of water extending for several miles over into the London area whereas the water area just north of the town of Overton is only two or three locations wide. Structural conditions, well spacing and rates of withdrawal are contributing factors in the irregular pattern.

Fluid Withdrawal vs. Reservoir Pressure

The reservoir pressure in the East Texas field is maintained by reason of the hydrostatic head of salt water in the Woodbine formation, which outcrops on the surface between Dallas and Fort Worth. It has been found that the rate of withdrawal of fluids from the East Texas field has a very definite relationship to the reservoir pressure and may be reduced to a mathematical equation.[3, 1e]

The pressure in the East Texas reservoir can be maintained at a certain point, if the daily average rate of withdrawal of approximately 600,000 to 650,000 bbl. of fluid is not exceeded.[7] The relationship of the reservoir pressure to the oil and water production from the field by months since 1931 is shown in Fig. 3. This graph shows the oil production as reported by the U. S. Bureau of Mines and the water production as calculated from periodic reports from the Texas Railroad Commission. The reservoir pressures were taken at minus 3300 ft. and reported by engineers of the Railroad Commission. It will be observed that the volume of

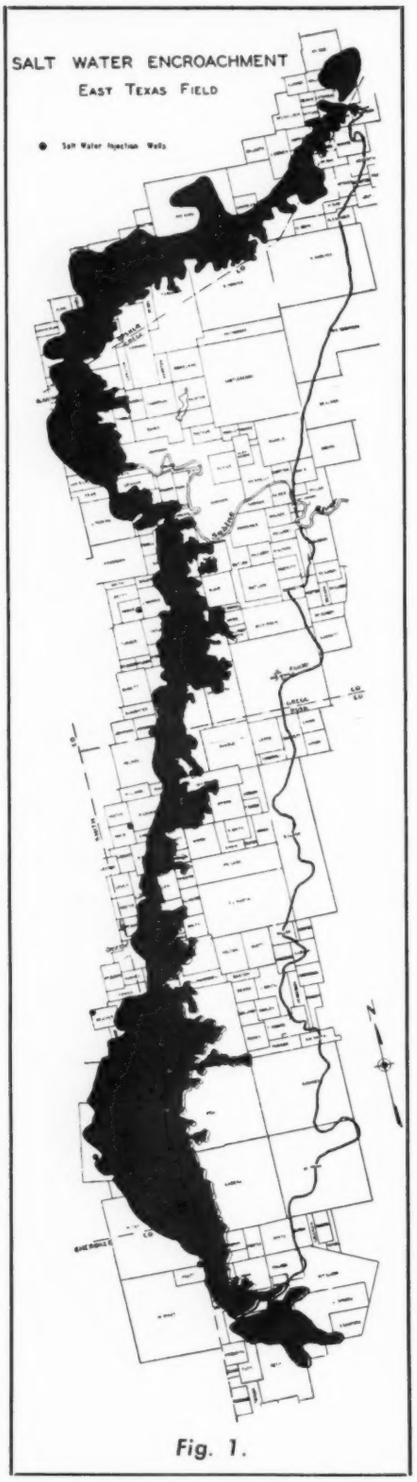


Fig. 1.

salt water produced has increased in relation to the amount of oil produced, to the extent that approximately one-half of the total fluids removed from the reservoir was salt water in May, 1943.

In an effort to reduce the volume of salt water produced, the Railroad Commission has permitted wells producing in excess of 100 bbl. of water per day to be shut down and their oil allowable produced by other wells on the same lease that produce less water. During the month of May, 1943, 284 wells producing in excess of 100 bbl. of salt water per day were shut down under the Commission's order. These wells had an average oil allowable of 13.21 bbl. per day and were producing an average of 345.47 bbl. of salt water per day at the time they were shut in. Information with respect to these wells is shown in Table 2.

The oil and water production, the salt water injected, and the reservoir pressure by months for the last 8 months are shown in Table 3. It will be observed that the reservoir pressure has been maintained to a remarkable degree over this period of time and has actually increased since the first of the year (1943), whereas the net withdrawal rate was less than 650,000 bbl. per day.

Salt Water Injection Program

As mentioned, the return of salt water to the Woodbine sand began in June, 1938. During the month of May, 1943, there were 56 salt water injection wells in operation, the details of which are shown in Table 1.

Operators with a large number of salt water producing wells found it expedient to install salt water disposal systems to take care of the water produced on their own properties. Many such systems were installed at costs varying from $15,000 to more than $100,000 each. Obviously smaller operators with few wells were not in a position to install such expensive facilities for disposing of their salt water. An attempt to install a coöperative injection system was made in July, 1941,[4] when an operator proposed to the Railroad Commission that he be permitted to drill a salt water disposal well west of the productive limits of the field and take water from different companies in that area. As a result of this proposal, many conferences were held among East Texas operators that culminated in the formation of the East Texas Salt Water Disposal Company, a $2,000,000 Texas corporation, the stock of which is owned by 249 companies including 230 smaller companies.

The East Texas Salt Water Disposal Company began its operations in October, 1942, and has increased its activity rapidly since that time as shown in Fig. 4. During the month of May, 1943, the company injected a total of 2,928,503 bbl. of salt water, which is a daily average of 94,468 bbl. During that month the company served 266 different leases on which were located 1502 oil wells producing salt water.

In addition to the volume of salt water injected per day by the salt water company, the oil operators in the field

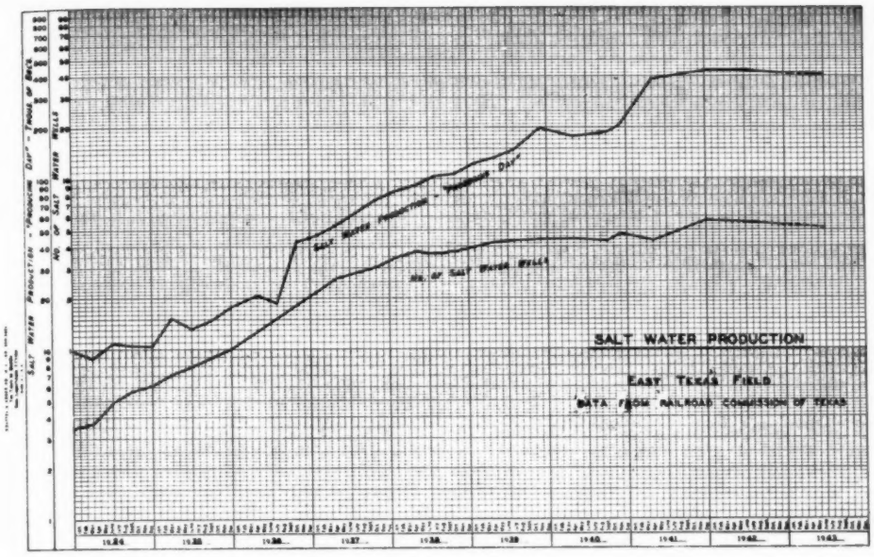


Fig. 2

who own injection wells (see Table 1) returned an average of 83,139 bbl. per day to the Woodbine sand during May, 1943, which made a total volume of water injected of 177,607 bbl. per day as shown in Fig. 5. This graph also shows the number of salt water injection systems in operation by months since June, 1938, as well as the cumulative barrels of water injected.

The salt water injection program during the last 8 months is clearly shown in Table 4, which shows the part the East Texas Salt Water Disposal Company is taking in the project.

Injection Wells

During the month of May, 1943, there were 56 salt water injection wells in operation in the East Texas field. A list of these wells with the volume of water injected during the month of May, and the wellhead pressures, together with other pertinent data are shown in Table 1. It will be observed that during the month of May, 1943, 5,505,822 bbl. of salt water were injected, which was a daily average of 177,607 bbl. and that the cumulative water injected since the program began in 1938 amounted to 87,591,680 bbl.

Of the 56 wells shown in the tabulation, 17 were drilled from the surface as salt water disposal wells. The other 39 wells were oil wells, which were drilled deeper and the oil sands protected by cementing a liner. The salt water encroachment map (Fig. 1) shows the location of the salt water disposal wells and indicates that seven of the wells were drilled west of the oil productive limits of the field where the water sand is thicker.

Wells completed as salt water injection wells within the limits of the field have the advantage of being able to be located at strategic points of surface drainage so that the water from the various leases can be collected by gravity and injected into the wells without the necessity of pump pressure. The inside wells have the disadvantage of being restricted to less water sand into which the salt water can be injected. The procedure for converting an oil well into a salt water injection well is approximately as follows:

If an "open type" system is used, a well with 7-in. casing should be selected; however, if a "closed type" system is to be installed a well with 5½-in. casing may be used. In either case a good string of casing that has been adequately cemented should be in the well to be converted. The hole should be cleaned out to its original total depth and drilled deeper to the base of the Woodbine sand, using mud for the circulating fluid, after which an electrical survey should be run. From the electrical survey the liner seat should be selected below a shale section, which is below 3320 ft. subsea (the original oil water contact in the field). The hole should then be reamed from the casing seat to the proposed liner seat. If a 5½-in. liner is run in a 7-in. cased well, the hole below the casing seat should be reamed to 7 in. or more in diameter. A bridge plug of cement, sand or other material, should be placed just below the liner point to prevent cement going below that depth. The liner should be of sufficient length to extend a minimum of 40 ft. into the casing and the liner should be cemented to the top. After the cemented liner has set for at least 48 hours it should be tested with 600-lb. pressure for at least 30 minutes to conform to the requirements of the Railroad Commission. The cement plug should then be drilled from the liner and the hole underreamed from the liner seat to the base of the sand using gas lift and reverse circulation. When the underreaming has been completed the well should be back flowed for a sufficient length of time to clean the well bore thoroughly.

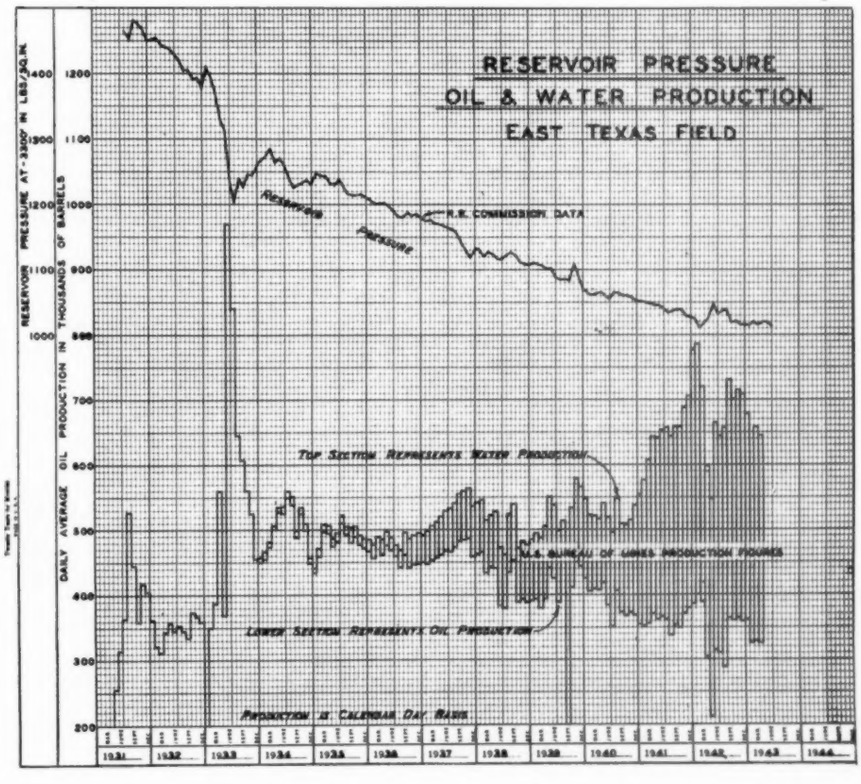

RESERVOIR PRESSURE
OIL & WATER PRODUCTION
EAST TEXAS FIELD
RESERVOIR PRESSURE
R.R. COMMISSION DATA
TOP SECTION REPRESENTS WATER PRODUCTION
U.S. BUREAU OF MINES PRODUCTION FIGURES
LOWER SECTION REPRESENTS OIL PRODUCTION
PRODUCTION IS CALENDAR DAY BASIS
RESERVOIR PRESSURE AT -3300' IN LBS./SQ.IN.
DAILY AVERAGE OIL PRODUCTION IN THOUSANDS OF BARRELS

Fig. 3

In an "open type" system, cement lined tubing equipped with a suitable packer should be run into the hole and set in the last joint of the liner. In the "closed type" system, steel tubing has been used for the injection string and in some instances, water is injected directly into the casing with no tubing used as an injection string. The cost of converting an oil well into a salt water injection well, including the cost of a string of cement lined tubing and using the method above described, is approximately $12,000.

In the drilling of new salt water disposal wells from the surface, the East Texas Salt Water Disposal Company has in several instances set 7-in. cement lined casing into which the salt water was injected. In other of its wells, the practice used by other operators in the field has been followed, that is, 7-in. steel casing was set below the oil sand and 4½-in. cement lined tubing used as the injection string. In drilling the new salt water injection wells, the hole below the surface pipe was drilled to 9⅝ in. in diameter and to a depth just above the estimated top of the Woodbine sand. The hole at this point was reduced to 6¼ in. in diameter and drilling continued to the base of the Woodbine sand after which an electrical log was run from the approximate casing point to the bottom of the 6¼-in. hole. The seat for the 7-in. casing was selected from the electrical log and after the 7-in. casing was set, cemented and tested by the Railroad Commission, the hole below the casing seat was underreamed to 8 in. in diameter to the total depth, using gas lift and reverse circulation. The well was back flowed a sufficient length of time to clean the hole thoroughly.

If cement lined casing were used the well was now ready for the injection of salt water, but if steel casing were used, the cement lined tubing was run on a packer after which the injection of salt water began. The cost of drilling a new well by this method, including the cost of 7-in. cement lined casing, was approximately $14,800 and where steel casing with 4½-in. cement lined tubing was used, the cost was approximately $16,450. In 7-in. cement-lined casing wells, an injection of 15,000 bbl. per day under gravity flow was obtained. In wells equipped with 4½-in. cement-lined tubing, as much as 10,000 bbl. per day has been injected under gravity flow.

TABLE I

Salt water injection wells, May, 1943, East Texas field

Operator	Lease	Well No.	Wells connected	Well-head pressure	Bbl. of water injected		Injection started
					For month	Cumulative	
East Texas Salt Water Disposal Co.	Tom Bell	18	23	Vac.	71,378	1,874,681	3- 1-39
	C. O. Christian	6	57	Vac.	108,077	946,675	12- 6-40
	S. S. Cook	5	73	Press.	193,549	717,410	1-17-43
	L. J. Everett	1	106	Vac.	192,224	412,538	3- 8-43
	J. D. Henson	7	80	Vac.	72,440	137,280	3-24-43
	W. B. Kee	3	85	Vac.	164,285	362,754	2-27-43
	J. S. King	9	44	Vac.	141,230	1,218,379	4-29-41
	J. A. Layne	1	67	Press.	144,586	4,591,579	10-13-39
	W. R. Nicholson	16	60	Press.	23,753	234,266	9-27-41
	H. A. Pace "B"	38	55	Vac.	139,383	5,437,009	6- 1-38
	Bryan W. Payne	1 & 2	182	Press.	499,307	1,500,567	1- 3-43
	Jack Pew	1	165	Vac.	287,910	407,492	4-15-43
	T. C. Ramey	1	43	Vac.	112,446	3,070,799	10-26-40
	Walter Shaw	3	41	Vac.	79,260	198,630	4- 5-43
	C. R. Starnes	1	59	Vac.	55,880	55,880	5-22-43
	H. J. Thomas	5	29	Vac.	87,081	863,976	11-19-40
	A. L. Walker	4	117	Vac.	48,851	190,037	12-10-40
	W. R. Wolford	7	15	Press.	98,999	343,939	1-26-43
General American	A. J. Sanders	7	55	Press.	165,255	715,029	1-15-43
	Thomas "A"	13	20	Press.	133,249	206,070	4-13-43
Gulf	A. Douglas	1	85	Vac.	277,787	2,169,344	8-12-40
	Harry Florey Fee	1	42	Press.	144,191	1,447,019	12- 5-40
	J. W. Trimble	1	150	Press.	188,551	2,724,359	3- 2-40
Humble	L. D. Crim	49-S	28	Press.	4,523	72,381	7-25-41
	Johnston D. "A"	1-S	7	Vac.	10,011	1,147,445	7-28-39
	M. C. Thompson	1-S	13	Vac.	10,017	195,486	7-11-39
	A. L. Walker	12	....	.....	.....	41,933	12-10-40
Magnolia	L. J. Everett	35	53	Vac.	54,895	775,980	12-21-41
	M. E. Peterson	6	70	Vac.	87,352	1,399,433	7-22-41
	John Radford	45	69	Press.	87,057	2,869,649	10-12-40
	J. R. Wright	43	50	Press.	42,915	791,819	2-13-40
Ohio	M. M. Cross Unit	9 & 12	26	Press.	185,324	7,359,960	11- 2-39
	J. Sadler Unit	1 & 2	42	Press.	239,974	6,655,830	4-20-40
	J. H. Sharp	4	25	Vac.	137,891	4,123,540	8-15-41
	M. L. Thompson	9	12	.....	150,393	1,692,761	10-24-40
Richardson	Mayfield	2	29	Vac.	92,200	2,668,511	2-17-41
Selby	Snavely Heirs "A"	2	50	Vac.	54,020	439,682	7-15-42
	Snavely Heirs "D"	13	21	Vac.	53,157	786,851	2-16-41
Sinclair	A. S. Jarvis "A"	9	58	Vac.	136,635	2,405,490	7-13-40
	Mayfield "A"	49	28	Vac.	84,920	2,917,372	1-16-40
	Mayfield "B"	20	27	Press.	25,783	25,783	5-15-43
	Mayfield "B"	21	27	Press.	44,045	1,161,626	7-13-40
	Peter Tipps	14	4	Press.	41,818	1,631,509	5- 6-40
	Amanda Wiley	9	3	Vac.	49,500	2,641,937	9-21-39
	Bunch Wilson	9	21	Vac.	109,847	4,939,532	7- 7-39
	R. C. Wright	19	46	Vac.	82,290	2,485,892	8-10-40
Stanolind	R. A. Moores	3	13	Vac.	48,454	1,639,228	5-29-39
	Newman	3	33	Vac.	39,923	1,038,726	7-28-40
Texas	Mae Blackwell	20	23	Vac.	16,001	165,815	1-12-41
	W. T. Chappell	11	10	Vac.	.....	440	12-15-41
	A. G. Dearing	9	9	Vac.	11,560	158,434	10-10-41
	A. S. Jarvis	16	22	Vac.	40,106	761,750	10-23-40
	Phillips	5	9	Vac.	55,721	1,352,720	1- 3-41
	L. Radford	1	6	Vac.	15,676	336,036	12-16-40
	W. D. Walker	12	16	Vac.	.....	110,522	4- 8-41
	J. W. Wilson	10	13	Vac.	43,149	1,218,791	3- 4-40
	E. M. Woods	12	10	Vac.	9,078	304,078	11-13-40
Vaughn	W. O. Alford	14	13	Press.	6,465	113,546	7- 6-41
	L. P. Thrash	13	10	Press.	5,450	34,325	7-15-42
	Total	56	2,549		5,505,822	87,591,680	
	Daily average				177,607		

Treatment for Injection

Woodbine water in the East Texas field contains approximately 38,000 p.p.m. chlorides and approximately 65,000 p.p.m. total solids. The iron content is approximately 14 p.p.m. and the bicarbonates 575 p.p.m. When a "closed" salt water disposal system is used no air is permitted to come in contact with the water; after the oil is separated from the water in a closed pressure type treater, the water is ready for return to the reservoir. Of the 56 salt water injection systems in operation during the month of May, 1943, in the East Texas field, six systems were using the "closed type." Where a close control of the producing operations is possible, the closed system has many advantages including the elimination of the chemical treatment of the water and the possible use of steel pipe and tubing for transporting the water.

In the open systems, however, considerable treatment of the water is necessary before it can be successfully returned to the reservoir.[5,6] In general, the treatment consists of the separation of the oil from the water, aeration to oxidize the iron, chlorination to kill bacteria or prevent its growth, addition of alum and lime to expedite the flocculation and precipitation of foreign matter, and finally a sufficient retention time for the sedimentation process to be completed.[7,8]

Various methods are used to accomplish the proper treatment of the water; for example, aerating slabs are used in some instances, as shown in Fig. 12, whereas aerating towers that break the water into droplets are used where sufficient head is available. The addition of

chlorine for bacteria control is also done in several ways as explained later. Likewise the addition of lime and alum may be through dry chemical feeders or injected into the flow of salt water in a liquid state depending on the design used by the individual operator. There are several sludge blanket accelerator treating plants in the field that accomplish the treating process in a compact plant. There are also some operators in the field who use very little or no chemical treatment in their open systems with a remarkable degree of success. Most operators, however, attempt to keep the iron content of the water going into the injection wells below 0.5 p.p.m. and with a residual chlorine content of not less than 0.5 p.p.m. for positive bacterial control. The greatest difficulty from plugging of the wells has come from the bacteria, iron, and carbonates, in the order mentioned. There has been some recent suggestion of the possibility of colloidal silica being the source of some plugging action.

When the face of the sand becomes plugged, the wells are either acidized, back flowed, or cleaned out. Sometimes all three processes are necessary to put the well in condition to take water under gravity. When the well has become plugged because of a high iron content of the injected water, a treatment with sulphuric acid has been found to open up the sand, whereas when the plugging material is bacteria or carbonates, a treatment with hydrochloric acid has been necessary. Some wells have responded to a treatment with mud acid, which might indicate some basis for the belief that colloidal silica may be causing a part of the plugging. It is generally believed that back flowing the well, usually by gas lift, will improve the injection capacity. After the wells are treated with acid it is considered good practice to back flow them at a very high rate if possible. Some injection wells have refused to respond to various acid treatments, making it necessary to clean out the well bore and possibly underream the sand section. As a clean out job is rather an expensive method, the use of acid has been generally followed, sometimes with the application of pump pressure to maintain the injection rate into the well.[9]

Cost of Injection

The cost of providing salt water disposal facilities in the East Texas field varies widely on the basis of the volume of water injected per day, because of the many different types of treating plants and principally because of the wide variation in the amount of gathering line necessary to collect the water. In the discussion herein on the drilling and completion of salt water injection wells, the experience of the East Texas Salt Water Disposal Company was recited, wherein it was shown that the cost of converting an oil well into a salt water disposal well was approximately $12,000 and the cost of drilling a new well from the surface was approximately $15,600, depending on the method of completion.

A review of the costs for drilling salt water disposal wells by various operators in the field before the East Texas Salt Water Disposal Company started its operations, revealed that the average cost of converting 24 oil wells into salt water injection wells was $14,960 and the average cost of drilling 12 salt water injection wells from the surface was $26,072. Four of the wells drilled from the surface were gravel packed, which added slightly to the cost.

The average cost of installing 23 salt water treating plants was $10,164. The size of the treating plants varied considerably; some were designed for 1500 bbl. per day, whereas others were estimated at 6000 bbl. per day capacity.

The cost of the gathering lines varied widely depending on the distance between the leases to be served and the size and kind of pipe lines installed. In some instances salt water disposal facilities were installed to take care of water

Fig. 4

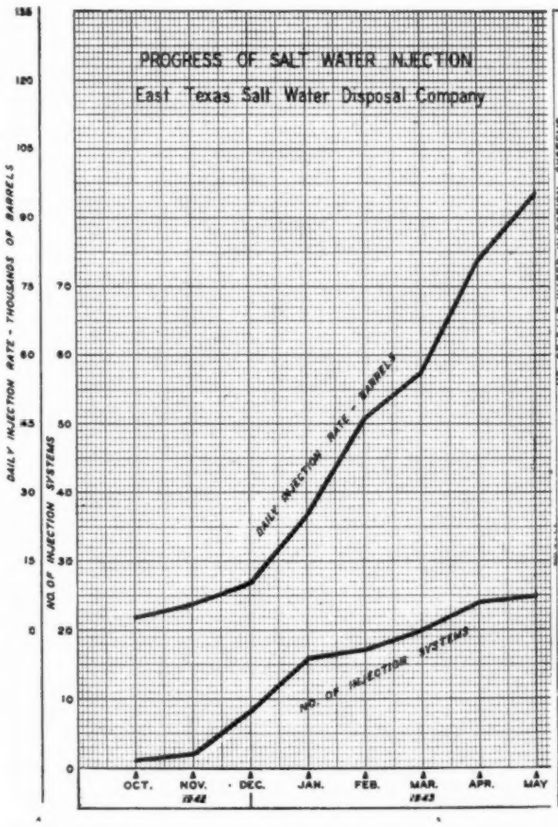
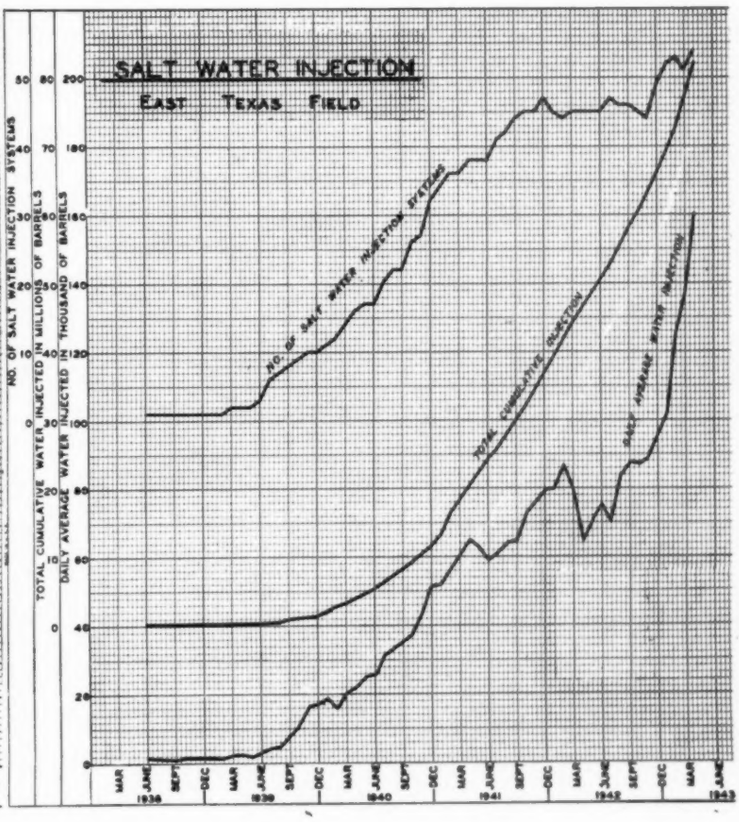


Fig. 5



produced on a single lease, in which case the gathering lines represented only a small part of the total cost; in other cases, one disposal plant would serve many leases widely separated—in which cases the cost of the gathering lines exceeded $100,000. In the operation of the East Texas Salt Water Disposal Company, gathering lines were installed to take care of all leases not otherwise served that were nearest the injection well. Consequently, the cost per barrel for gathering lines under this program was less than where the leases were widely separated. The overall cost for disposal facilities of the East Texas Salt Water Disposal Company at the time 100,000 bbl. of salt water per day were being injected, was approximately $12.00 per bbl. It is expected, however, that when the systems are finally completed and loaded to capacity that the cost per barrel will be reduced below this figure.

At the time the salt water company was organized, a study was made to determine the cost for injecting water in the East Texas field. The results of this study are shown on the curve in Fig. 6. Actual operating cost data were obtained from many operators in the field and used as a basis for this curve. It may be readily observed that where small volumes of water are handled per day the cost per barrel is relatively higher, running as much as 11 cents per bbl. when about 200 bbl. per day are injected. The cost rapidly decreases as the daily injection rate is increased to a more or less stable cost per barrel after the 3000 bbl. rate is reached.

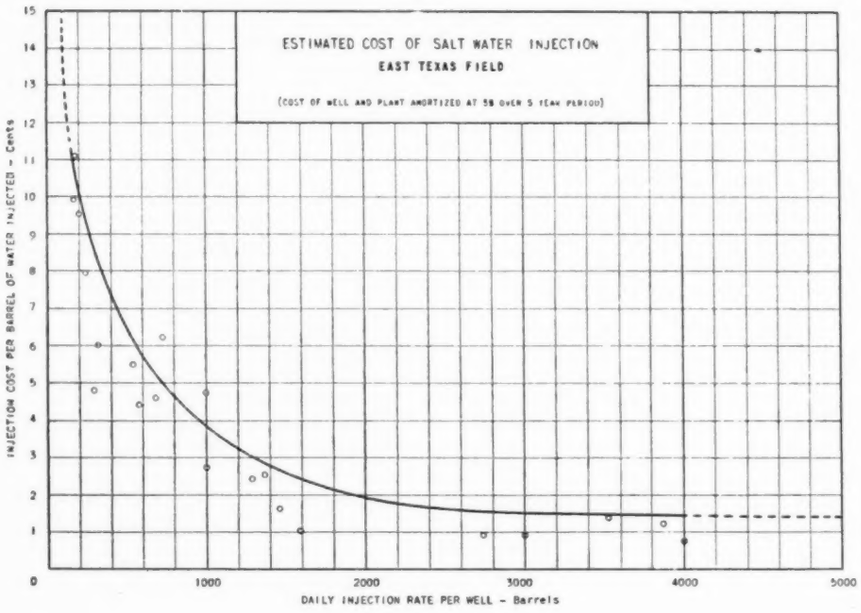
The East Texas Salt Water Disposal Company charges 1.8 cents per bbl. for the disposal of salt water by returning it to the Woodbine sand. This rate was established after a detailed study of injection costs in the field was made by a group of accountants. It was realized that in the early history of the salt water company the rate would be insufficient to meet expenses, but it was believed that as the volume of water injected per day increased, the cost per barrel would be reduced. Because of the necessity for much chemical treatment of the water during the summer months and the more frequent plugging of the injection wells during that period, the expense has been unusually high. Although the salt water company has not been able to show a profit on its operations to date, it is expected that this condition will be remedied in the very near future.

Fig. 7. Asbestos cement pipe for salt water gathering lines are laid to grade to utilize gravity flow to collection centers from which the water is pumped to the injection wells

The Texas Railroad Commission cooperated with the operators in the East Texas field in the program of returning salt water to the Woodbine sand to the extent that an additional barrel of oil is allowed for every 50 bbl. of salt water injected. The salt water company charges 90 cents ($1.8c \times 50 = 90c$) for injecting 50 bbl. of water; the operator receives one additional barrel of oil allowable worth $1.25 per bbl. After royalties, lifting costs, taxes, and other expenses are deducted, approximately 90 cents is left for payment for the injection of the water. Therefore the operator is relieved of the financial burden of returning the water to the sand.

In cases where the salt water producer has no other wells from which the additional oil may be produced, other operators with properties better located in the field have agreed to produce the additional oil for such operator and pay him 90 cents per bbl. for such oil. The plan has been refined to the point that the salt water producer can transfer his bonus oil allowable to other operators in the field and the bonus oil producer pay the proceeds directly to the salt water company. Thus the salt water producer has his water returned to the sand without cost to him. The operators who produce the bonus oil for others do so in order to encourage the return of salt water to the producing formation as a means of maintaining the pressure in the reservoir. It has been estimated that the proper maintenance of pressure in the East Texas field will increase the recovery between 350 million and 625 million barrels of oil.[3] This estimate is based on the difference in recovery factors that will apply to the remaining oil reserve in the East Texas field if the field is produced under an efficient water drive as compared to a less efficient recovery obtained under partial gas drive.

Fig. 6



Chlorination for Bacteria

Sulphate-reducing bacteria are found in great numbers in East Texas salt water and are the source of much difficulty in treating the water for subsurface injection. It is believed that the bacteria get into the water from exposure to the air or surface equipment, but are not produced in the water from the wells. These bacteria can be eliminated by several methods including: (1) the application of heat in excess of 170°F. or (2) the use of a bactericide. (See reference 10 for a discussion

of the effect of bacteria on the injection of water into sand.) Chlorine is most generally used to kill the bacteria. The chlorine is applied in several ways including powdered calcium hypochlorite and in the liquid form discharged as gas from cylinders. Chlorine has a great affinity for water and therefore is readily soluble. Various types of chemical feeders are used in disbursing the dry form of chlorine; when liquid chlorine from cylinders is used, a diffusing thimble is attached on the end of copper tubing and immersed in the stream of salt water to a depth of about 18 in.

Due to the difficulty of obtaining chlorine in any of its forms because of urgent war demands, its generation by electrolysis has been developed to a reasonably satisfactory degree. Several companies, including the East Texas Salt Water Disposal Company, are generating chlorine by this method.

The generation of chlorine by electrolysis employs low voltage, high amperage direct current. The current may be generated by a d-c. generator driven by an electric motor or gas engine where electric power is not available. Rectifiers for converting alternating current into direct current have been found very satisfactory for this service. The East Texas Salt Water Disposal Company is using a number of rectifiers that convert 440-volt, 3-phase, alternating current to 6-volt, 500-amp. direct current. These rectifiers cost approximately $680 each.

In connection with the rectifiers or d-c. generator sets, carbon graphite electrodes are used. The electrodes are submerged in the salt water, which serves as the electrolite. Placing the electrodes approximately 18 in. below the surface of the water has been found desirable to eliminate excessive loss of chlorine gas from the bubbles rising to the surface and permitting the escape of the gas into the air. The carbon graphite plates are usually 1¼ in. thick, 6¼ in. wide and 36 in. long; a group of five plates spaced ⅜ in. apart with bakelite insulators are connected with 1/0 solid copper wire. Holes ⅝ in. in diameter and 4 in. deep are drilled in the middle of the graphite plates into which copper wire is inserted and tamped with lead wool and mercury to a depth of 3 in. A bakelite tube extending above water level, is then inserted over the copper wire and insulated with 1 in. of paraffin.

It has been found that boiling the carbon graphite plates in paraffin will almost entirely fill the pore space and result in a much longer life of the carbon plate. Approximately 2 sq. in. of plate surface is used per ampere. In the nest of 5 carbon plates, each plate will have 225 sq. in. of surface; utilizing the 4 exposed sides of the positive or negative plates, a total of 900 sq. in. of surface is made available; this area divided by 500 amp. (the capacity of the equipment) equals 1.8 sq. in. per amp. At 80 percent efficiency, this equipment will generate 1 lb. of chlorine per 18 amp. over a 24-hour period. A 500-amp. machine would therefore generate 27.8 lb. of chlorine per day. This has been found sufficient to treat 5000 bbl. of East Texas salt water per day and leave a residual chlorine of from 0.3 to 0.5 p.p.m. on the downstream side of the filters. The amount of chlorine necessary properly to treat salt water depends on a number of factors, including the quantity of bacteria present, the iron content of the water, the treating cycle and the retention time before injection.

Salt Water Gathering System

Salt water in the presence of oxygen is highly corrosive. When a "closed type" system is used, and all air is excluded from contact with the water, steel pipe can be used without difficulty, but in the "open type" systems that predominate in the East Texas field, the use of steel pipe is prohibitive because of the short life of steel in this service; however, steel pipe may be successfully used in handling salt water if the pipe is cement lined. When other materials were hard to obtain, it was necessary for much cement-lined steel pipe to be used for salt water gathering lines. Although cement-lined steel pipe has some advantages for salt water gathering lines such as its ability to withstand reasonably high pressures, the exterior of the pipe is subjected to considerable corrosion when it is laid in areas that have been impregnated with salt water.

The material most generally used in salt water gathering lines in East Texas is asbestos cement pipe, which is not only non-corrosive to salt water, but is also less expensive than cement-lined steel pipe.[11] The relative costs of the two kinds of pipe are about as follows:

Dia., in.	Second-hand steel, cement lined, cost per ft.	Asbestos cement, Class 100, cost per ft.
4	$ 0.5490	$ 0.4833
6	0.9119	0.7479
8	1.2540	1.0356

There are two types of couplings used for joining the asbestos cement

TABLE 2

Large water wells (100 bbl. or more) shut down. May, 1943, East Texas field

Operator	Number wells	Oil allowable	Water production	Percent water
The Atlantic Refining Co	1	20.00	139	87.0
Allstate Refining Co	2	34.33	1,059	96.86
Barnett Petroleum Co	1	10.78	384	97.27
Binaggio, R	1	15.56	296	95.0
Bracken, J. A	1	11.43	275	96.0
Bradley, W. W	3	43.00	1,191	96.52
Burwyn Oil Corp	3	39.50	839	95.50
Cities Service Oil Co	10	104.49	3,486	97.09
Christian, H. S	1	9.00	219	96.00
Coffield, H. H	2	16.80	827	98.01
Delta Drilling Co	2	20.88	1,031	98.01
Devonian Oil Co	2	11.81	579	98.00
Everts Drilling Co	1	16.33	776	98.0
Felsenthal, S. J	2	34.45	611	94.66
Gaskill & Bates	1	20.00	247	88.0
General Crude Oil Co	3	30.97	1,466	97.93
Gilliland, J. W	4	80.00	1,272	94.08
Gulf Oil Corp	4	22.69	1,108	97.99
Hughes, K	2	20.88	880	97.68
Humble Oil & Refining Co	8	112.75	3,395	96.79
Hunt Oil Co	22	371.90	4,877	92.91
Iowa Payne Oil Co	1	5.61	407	98.64
Jackson, Wise & Snedden	2	17.62	436	96.12
Johnston & Owens	2	21.99	406	94.86
Lester & Duffield, Inc	2	26.57	450	94.42
Leisk, William O	1	10.00	350	97.22
Magnolia Petroleum Co	8	113.18	3,163	96.55
Manahan Oil Co	3	12.40	595	97.96
Meco Production Co	5	57.46	1,897	97.06
Midfield Oil Co	4	16.02	936	98.32
McMahon, C. L	6	89.42	2,527	96.58
McMillan, L. O	7	92.00	2,618	96.60
The Ohio Oil Co	25	278.96	13,220	97.93
Phillips, B. F	1	4.00	47	92.0
Pineda Producing Co	4	60.67	516	89.47
Ray, et al	4	51.97	1,364	96.33
Reinier, J. F	1	20.00	270	93.0
Shell Oil Co., Inc	5	78.20	2,073	96.36
Sinclair-Prairie Oil Co	56	799.62	19,195	96.0
Sklar Oil Corp	1	12.50	326	96.0
Standard Oil Co. of Kansas	1	11.00	345	97.0
Stanolind Oil & Gas Co	3	31.59	765	96.03
Starnes, C. R	2	18.81	890	97.93
Stodel Oil Co	1	20.00	313	93.99
Stidman & Thrasher	1	4.14	240	98.0
Sun Oil Co	33	508.16	13,927	96.48
The Texas Co	16	137.99	2,810	95.32
Texas Canadian Oil Co	6	102.00	1,336	92.91
Tide Water Associated Oil Co	5	85.42	843	90.36
Wilson, W. H	1	12.00	355	97.0
Winston Oil Co	1	3.69	536	99.32
Totals	284	3,750.54	98,113*	96.32
Average		13.21	345.47	96.32

The calendar day average (considering proratable and marginal wells) 91,048 bbl.*

pipe. One manufacturer supplies a sleeve made of asbestos cement, which is slipped over the joint with a rubber ring on either side of the pipe joint. A special tool or jack is used in making joints of this kind but the operation is not a difficult one and the pipe can be quickly put together. The other type of joint is a Dresser type coupling; an asbestos cement mid ring is used with a rubber ring on either side with a cast-iron follower fastened with 3 galvanized bolts. Where conditions permit, several joints of pipe are coupled together before being lowered into the ditch as shown in Fig. 7. The type of joint illustrated in this figure is likewise easy to assemble and both types of joints permit a degree of flexibility.

Another kind of pipe has been used with a degree of success in handling salt water in the East Texas field; it is a wood fiber coal tar product and is especially adapted to low head gravity lines. The pipe is put together with a friction coupling and can be rapidly laid. Its initial cost is low compared to cement-lined steel pipe or asbestos cement pipe. Its use is restricted to lines where water hammer is not present and where the temperature of the water is not greater than 100°F. It has been found that hot water makes the material soft and results in many leaks. The pipe has very little reclaim value, but where it can be used its principal advantage is in the initial low cost.

An attempt has been made to install gravity collection systems wherever possible. The gathering lines are consequently laid to grade, with vent lines installed at low places in the line to prevent the formation of air pockets. Many of the lines are laid so that scrapers can be run through them, but in the majority of cases this degree of refinement has not been attained. The design of the gathering system is a highly important factor[12] in the salt water disposal system for the reason that the cost of the gathering system is oftentimes more than two or three times the cost of the disposal well and treating plant.[17]

TABLE 3
Total fluid withdrawal and reservoir pressure, East Texas field

Month	Daily average production, bbl.				Water injected per day bbl.	Net fluid withdrawal per day bbl.	Reservoir pressure (R. R. Comm.) first of month, lb. per sq. in.
	Oil (tanks)	Oil (reservoir vol.)	Salt water	Total fluid			
1942							
October	365,075	462,120	364,728	826,848	87,007	739,841	1,020.71
November	356,722	451,546	353,379	804,925	88,932	715,993	1,016.24 (—4.47)
December	360,105	455,829	351,438	807,267	95,319	711,948	1,017.12 (+0.88)
1943							
January	325,061	411,469	319,956	731,425	102,059	629,366	1,015.71 (—1.41)
February	324,627	410,920	317,289	728,209	124,436	603,773	1,020.55 (+4.84)
March	325,753	412,345	315,856	728,201	137,064	591,137	1,016.14 (—4.41)
April	354,051	448,166	320,032	768,198	160,844	607,354	1,020.44 (+4.30)
May	342,759	433,872	305,930	739,802	177,607	562,195	1,019.16 (—1.28)

Filters

Several types of filters are used in the treatment of salt water for subsurface disposal in the East Texas field.[13] The type most universally used is the pressure sand filter; other types include the open sand filter, flannel bags, and excelsior sections in the closed systems.

The pressure filters are usually 72 in. or 96 in. in diameter with dished heads and about 5 ft. in the shell. They are constructed of steel plate approximately ¼-in. thick. Water enters the top of the filter through a spreader arrangement on the inside and after passing through the filter bed is taken out through a header system in the bottom. The dished head in the bottom of the filter is usually filled with concrete up to the shell with the discharge header embedded in the cement. The concrete is used to fill up the dead space in the filter and prevent the accumulation of bacteria. The filter bed is usually about 3 ft. thick and consists of the following sizes of gravel and sand:

Section	Mesh, in.	Layer thickness, in.
Bottom—Gravel	¾ to 1¼	3
Second—Gravel	½ to ¾	3
Third—Gravel	¼ to ½	3
Fourth—Gravel	⅛ to ¼	3
Top—Sand	0.4 to 0.5 mm	2 ft. 0
Total		3 ft. 0

A round sand and gravel is most desired with a coefficient of uniformity of 1.6, which is the relation of the length to the diameter. The filter beds cost approximately $8.00 per cu. yd. delivered.

A 96-in. pressure sand filter has a cross-sectional area of approximately 50 sq. ft. A rate between 2 and 3 gal. per min. per sq. ft. of cross-sectional area is used; a 96-in. filter operating at 3 gal. per min. would handle 5142 bbl. per 24-hour day. (See Fig. 8.)

The filters are backwashed at intervals depending on the amount of impurities removed by the filtering process. Backwashing once a day in East

Fig. 8. This battery of four 96-in. diameter pressure sand filters are so connected that any one can be backwashed without disturbing the flow through the others. Each filter handles approximately 3500 bbl. of salt water per day

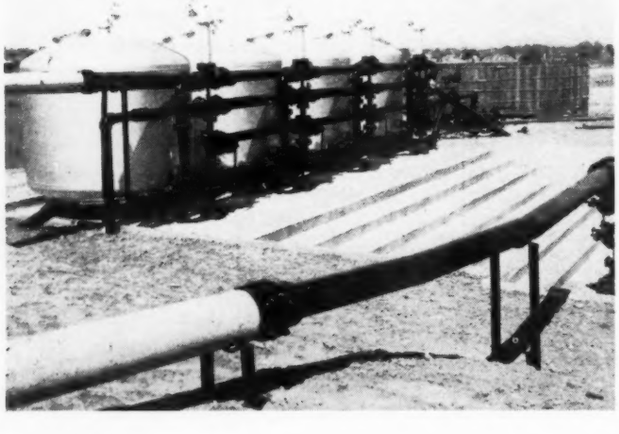
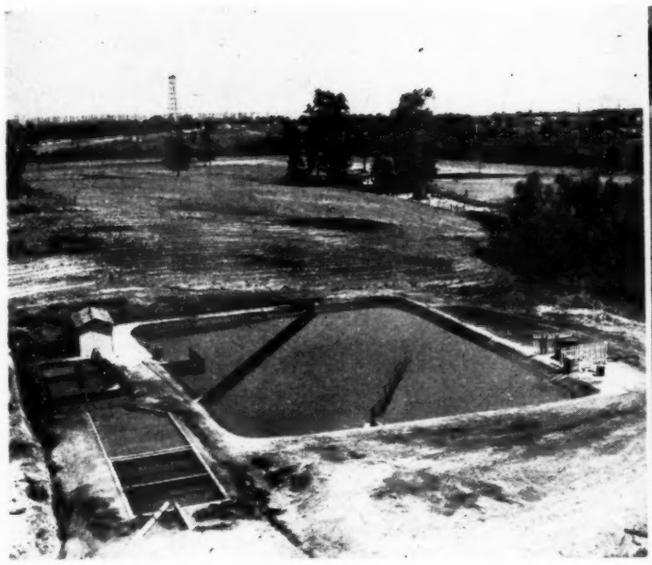


Fig. 9. Application of gunite concrete to floor of salt water pit. Reinforcing wire mesh may be seen in foreground, with air compressors in background



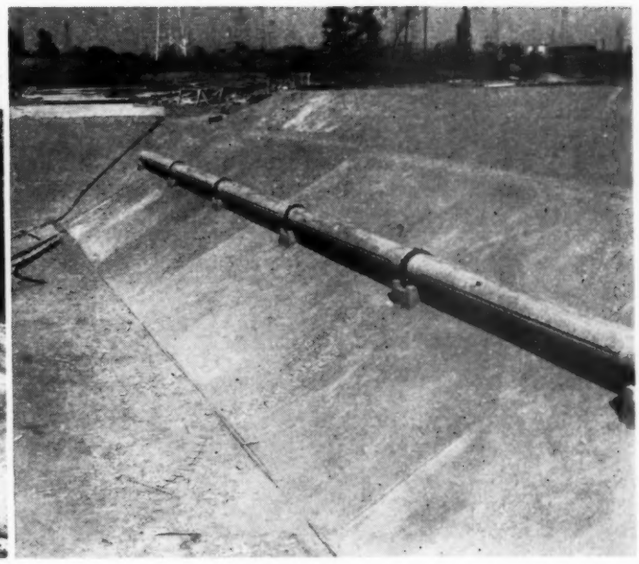


Fig. 10 (left). Salt water collection pit in East Texas field. The water enters the oil skimming pit in lower left corner, then passes over an aerating slab into the chlorinating chamber before entry into the gunite concrete pit of 10,000-bbl. capacity. Directional baffles may be seen in the larger pit. Fig. 11 (right). Gunite concrete salt water pit, showing asbestos cement pipe inlet header. Note slope of walls 1½:1

Texas is the general practice although backwashing every 12 hours is not uncommon. A backwashing rate of approximately 4 to 5 times the filtering rate has proved to be most satisfactory for removing foreign matter, which is mostly iron oxide.

Some operators use fresh water for backwashing the filters, but the usual practice is to use filtered salt water from an elevated tank or from a pump especially installed for this service. A weak solution of sulphuric acid has been used by at least one operator in backwashing filters to keep the filter bed free of iron oxide and calcium carbonate deposits. In such instances, the acid solution is used from day to day; brought up to strength after each use, requiring two backwash pits.

The open sand filters utilize the same type of filter bed, which is contained in a steel or concrete box, oftentimes utilizing a porous carborundum drain for the discharge header. When flannel bags are used, they are replaced each day and are believd much less efficient and less satisfactory than the sand filters. The excelsior sections are utilized in the closed-type treating system and serve in general to remove entrained oil from the water.

Salt Water Pits

Many earthen pits have been constructed in the East Texas field for the purpose of impounding salt water to be released into surface streams during times of high water. It is believed that many of the earthen pits constructed with the proper mixture of clay and sand or out of virgin earth, have been practically impervious. In general, however, earthen pits constructed above the surface level, the banks being made from material removed from the floor of the pit, permit a degree of seepage that renders them unfit for the storage of salt water. Furthermore salt water pits used in connection with salt water disposal systems must provide storage space with the least amount of contamination of the water. When earthen pits are used, fine silt has become mixed with the salt water, which material passes through the sand filters and into the disposal wells where considerable damage is caused by plugging the sand face.

Bacteria and other micro-organisms have been found to exist more abundantly in earthen pits than in other types of salt water storage. As these bacteria are the source of one of the principal treating difficulties, it is highly desirable to eliminate their growth and propagation as much as possible. The control of bacteria in the salt water, particularly during the summer months has been one of the most perplexing problems in the disposal of salt water in East Texas.[10]

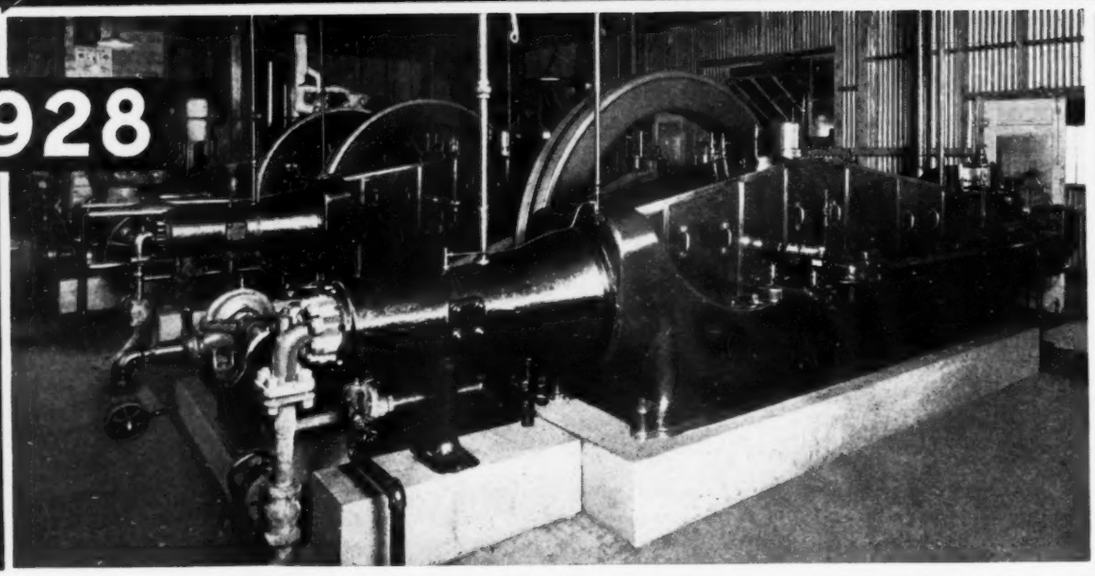
Many operators in the East Texas field who maintain salt water injection systems have provided redwood tanks or concrete reservoirs for the collection and storage of salt water in the process of returning it to the Woodbine sand. One of the most recent developments in the storage of salt water is the use of gunite concrete tanks or pits. "Gunite" is the trade name of sand cement mixture placed with a machine known as a cement gun.[14] In this process, one part of Portland cement is mixed with three parts of sand and discharged under air pressure through a nozzle where water is added and the mixture impinged against the prepared earthen base. Reinforcing steel, 10-gauge wire 6-in. by 6-in. mesh, is used for strength. The gunite is applied to a thickness of approximately 2½ in. in a continuous process as illustrated in Fig. 9. The sides of the pits are finished to a slope of 1½:1. Gunite applied in this manner has been found to be more dense and moisture resisting than poured concrete. It has also been found to be several times stronger than similar thicknesses of poured concrete. The use of reinforced gunite for lining reservoirs was first used in Muscatine, Iowa, in 1913.[15] In Texas the process has been used in the construction of irrigation ditches and canals in the Rio Grande Valley and for water tanks on Southwest Texas cattle ranches. Gunite for salt water pits in the East Texas field is used exclusively by the East Texas Salt Water Disposal Company and other operators in the field. Figs. 9 and 11 show gunite salt water pits under construction in the East Texas field.

The cost of constructing salt water pits by the gunite process is cheaper than poured concrete reservoirs. The cost of 7 gunite pits with a total

(Continued on Page 53)

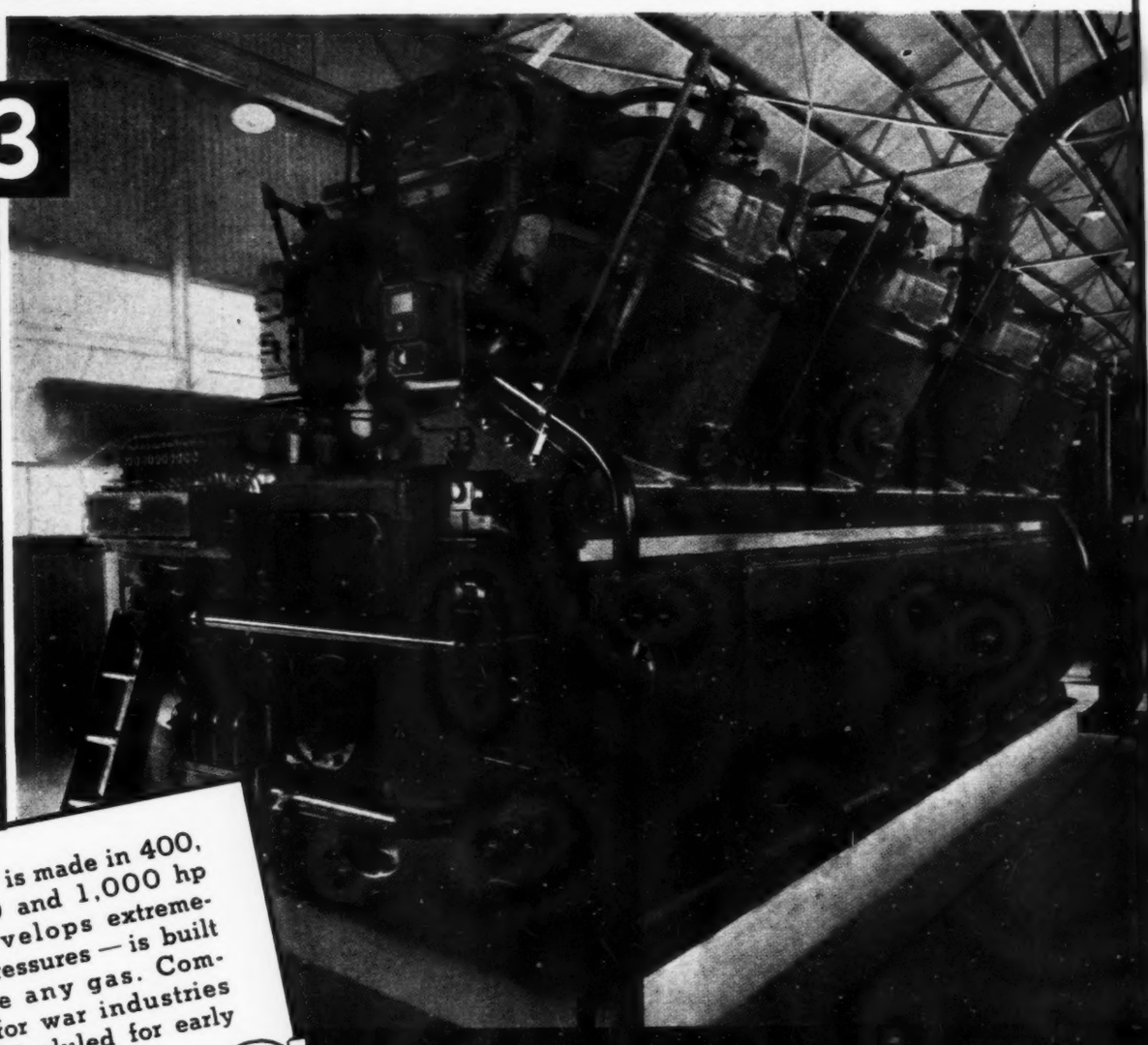
15 YEARS OF

1928



The 1928 helium installation. Main compressor plant at Dexter, showing 3 Cooper gas engines driving 4 - ½" diameter compressors.

1943



Type G-MV is made in 400, 600, 800 and 1,000 hp units — develops extremely high pressures — is built to handle any gas. Compressors for war industries can be scheduled for early shipment.

Compressor

New York Washington Bradford, Pa. Parkersburg, W. Va. Gloucester, Mass.

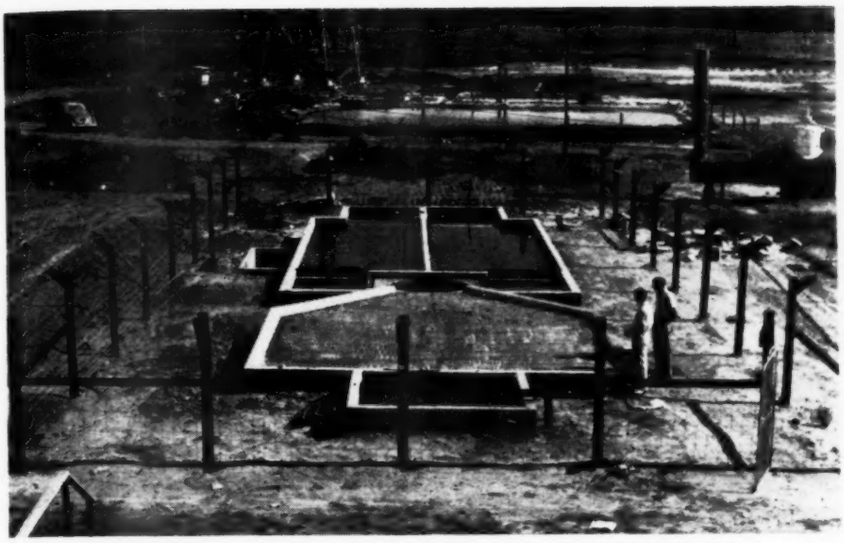


Fig. 12. Salt water treating plant utilizing slab aerator, settling pit and gravity sand filters (in far end of basin). Disposal well is in the background

(Continued from Page 49)

capacity of 51,500 bbl. cost an average of 72 cents per bbl. The excavation, fine grading and earth work cost 17 cents per bbl. and the actual gunite work costs 55 cents per bbl. Cost of gunite work was approximately 27 cents per sq. ft. of surface after all of the preliminary work had been done and the reinforcing placed in position.

Conclusion

The program for salt water injection in the East Texas field is believed to be the most outstanding conservation program ever attempted in the oil industry. The organization of the East Texas Salt Water Disposal Company is one of the finest pieces of coöperation among operators in the oil industry. The company was organized on a voluntary basis and operators owning over 16,000 wells in the field purchased stock in the company. Seventeen of the larger operators in the field bought their proportionate share of stock in the company as well as over 230 smaller operators. The program for returning salt water to the sand to relieve the pollution of surface streams and to maintain the reservoir pressure has been endorsed by the Texas Railroad Commission and the Petroleum Administration for War has assisted materially in the matter of obtaining the necessary materials for installing the facilities.

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TABLE 4
Salt water injection, East Texas field

Month	Injected by Salt Water Company			Injected by other companies			Total water injected	
	Total bbl.	Daily avg., bbl.	Percent	Total bbl.	Daily avg., bbl.	Percent	Total bbl.	Daily avg., bbl.
1942								
October	91,670	2,957	3.40	2,605,550	84,050	96.60	2,697,220	87,007
November	172,942	5,765	6.49	2,495,031	83,168	93.51	2,667,973	88,933
December	323,995	10,451	10.96	2,630,906	84,868	89.04	2,954,901	95,319
1943								
January	720,831	23,253	22.78	2,443,018	78,806	77.22	3,163,849	102,059
February	1,268,281	45,296	36.40	2,215,936	79,140	63.60	3,484,217	124,436
March	1,736,209	56,007	40.86	2,512,785	81,057	59.14	4,248,994	137,064
April	2,383,047	79,435	49.39	2,442,266	81,409	50.61	4,825,313	160,844
May	2,928,503	94,468	53.19	2,577,319	83,139	46.81	5,505,822	177,607
Total 8 months	9,625,478	39,611	32.65	19,859,026	81,724	67.35	29,484,504	121,335

Manila Rope Substitute

To try to help users of the smaller sizes of manila rope who may have remaining no usable rope or who are using rope that is unsafe because of wear, The Chain Institute, Inc., Chicago, Illinois, has studied the proper substitution of weldless chains for manila ropes, which are scarce due to the needs of the Army, Navy, and Maritime Commission.

The study by the Institute revealed that although capacity for the manufacture of welded chain is being taxed to the utmost to fill essential war demands, there does exist idle capacity for making weldless chain. This capacity, which under normal conditions meets civilian chain needs, has been partially idle for more than a year because steel was not available for weldless chain production.

The Institute then studied the breaking tests of weldless chains in comparison with manila rope, and prepared a table that brackets 10 ropes under 1 in. in diameter with the weldless chain that provides comparable strength for each.

For example: the smallest rope listed is 3/16 in. Manila rope in this size made to Federal Specification TR-601a has a breaking test of 420 lb. and wartime substitute fiber rope a breaking test of 336 lb. The comparable weldless chains are Tenso Type (No. 3) with breaking test of 375 lb., Lock-Link Type (No. 4) with a test of 405 lb., and Niagara Type (No. 4) with a test of 420 lb. Similar convenient comparisons have been worked out for rope sizes 1/4, 5/16, 3/8, 7/16, 15/32, 1/2, 9/16, 5/8, and 3/4 in.

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by Kork Kelley

Kork Kelley Production Engineering Company, Wichita Falls, Texas

ONE of the major factors in the pumping of an oil well is the synchronization of the producing ability of the well with the volumetric displacement of the working barrel of the pump in the well. In the type of field wherein a central power pumping plant is employed or in which any type of rod line jack is used, all wells connected to the power wheel receive the same length of stroke and the same number of strokes per minute, but the ability of each well to produce is individual in each case. No two wells will produce the same amount even though they are structurally the same both in depth and sand thickness, there being some element surrounding each well that causes it to produce differently from the offset wells. Due to this unexplainable condition, some wells, for example the smaller wells, are "pumped off" much sooner than the larger capacity wells, such as wells making water or what is termed a "straight time well." In hanging off the smaller wells from the power the power wheel becomes unbalanced unless some type of counterbalance is hooked on to offset the wells yet being pumped on the opposite side of the power wheel. These counterbalances are mostly the makeshift type, "grasshoppers," that cause endless expense and trouble, including accidents that occur very frequently in hooking off the wells or counterbalances. If the wells are not hooked off at the proper time, the face of the sand is damaged, the working barrel and its parts must pump without benefit of lubrication, stuffing-box rubbers are damaged due to a hot polished rod, and in some cases a surging or heading is occurring within the upper portion of the tubing.

If during the rest period of the well it is capable of filling in above the top of the producing zone each foot of rise is retarding the movement of oil from the reservoir to the drill hole, the amount of "fill in" is pumped out when the well is hooked on again.

Test Well

If this head of oil or oil and water could be kept pumped down or kept constant during a 24-hr. period, the ability of the well to produce tends to increase regardless of the age of the well. Actual tests were made on a well at Electra, Texas, producing 2 bbl. of oil and 4½ bbl. of water, which was pumped off in 2 hr. 55 min. By means of the stroke control installed and set to keep the well on a 24-hr. pumping period, the oil production increased to 4 bbl. whereas the water production was still 4½ bbl. The stroke control was installed in about 2 hr. by two men. This well was 22 years old. It is the opinion of the writer that 95 percent of all pumping wells are being overpumped today. Sand troubles could be eliminated if the movement of the oil from the reservoir into the well bore or pump could be kept or moved in a more orderly manner. When a well is pumped out faster than the oil is coming in from the formation, the greater fluid velocity entrains the loose sand around the well bore and carries it on into the pump. This condition can and will be eliminated if the fluid is pumped out at the same rate at which it flows into the drill hole from the formation.

The flow of gas from oil wells will be constant if the fluid levels are kept constant during the 24-hr. period. If the gas is being processed at a gasoline plant, the plant load will be more constant and less horsepower required.

Fluid pound in the working barrel of the pump, causing rod breaks, leaky tubing collars, and fluid cut cups is eliminated, if the length of stroke is adjusted to pump that amount of oil that flows into the working barrel. Obviously, there is no need of a 20-in. to 24-in. stroke if only 6 in. of fluid rises in the barrel. Guesswork with the stroke control herein shown is eliminated, inasmuch as there are about 1500 changes the pumper can make without a wrench, removal of nuts and bolts, or without shutting down the power as required with the present-day procedure. If the well is capable of making one bbl. of oil in 24 hr., the capacity of the working barrel can be selected by regulating the stroke length to pump one bbl. in 24 hr. regardless of the diameter of the pump. As the volumetric displacement is governed by the length of stroke, the same size working barrel used during the flush stage can be used during the entire life of the well. Because only the stroke needs to be changed to follow the drop in production, this alone would save hundreds of dollars in pulling and changing of pumps. In some cases wells make more water as they become older, which requires putting the larger pumps in again. Such procedure would not be necessary if the pumper could increase the stroke to take care of the increase in water as it is needed and still not overpump the well. There are about four sizes of working barrels from which to choose, that deal entirely with diameter of the bore and not the length of stroke, but the oil well during its life undergoes many volumetric changes, therefore economically meeting or adjusting these varied changes cannot be

KORK KELLEY

was born on an Ohio Oil Company lease near Findlay, Ohio—Was ignition engineer on first gasoline plant built west of the Mississippi River by Frank Henderson in the Allawe field, Oklahoma—Went to Tulsa, Oklahoma, on construction of 8 single-unit casinghead gasoline plants for the Oklahoma Petroleum and Gasoline Company—He installed and operated the first vacuum pump west of the Mississippi near Kiefer, Oklahoma—Was employed on construction and operation of casinghead gasoline plant of Producers Oil Company (later The Texas Company) near Kiefer, Oklahoma—Employed by Sinclair in 1917 during organization of company and had charge of construction and operation of vacuum stations and casinghead gasoline plants—Went to Wichita Falls for Belby Gasoline Company where he remained from 1921 to 1926—In 1928 drilled successful wildcat on leases at Electra, Texas, and formed independent company, Easter Oil Corporation, which he operated until 1935—Has devoted time since to development of production methods and equipment for oil wells—Is inventor of bottom-hole oil and gas separator, as well as stroke controls discussed in this article.

done by changing the size of the pump but can be done by changing the length of stroke of any size pump with this type of control.

Installation and Adjustment

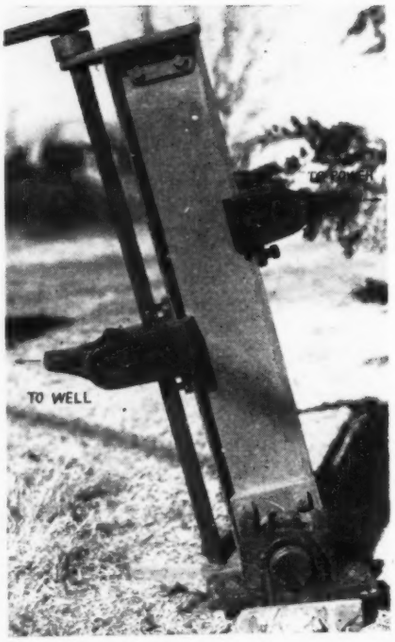
The stroke control is placed in the rod line as close to the jack as possible. This allows the operator to adjust the stroke by watching the "pounding" or hitting of fluid by the plunger, which eliminates any guess work in the adjustment. The traveling block that moves up or down by turning the threaded rod is self-locking and will stay at any desired stroke length; also by installing it near the jack the turnbuckle used for spacing the valves of the pump can be eliminated. When it is desired to "tap bottom" the length of stroke is increased until the traveling valve begins to hit bottom. The well can be "picked up" much easier than by the use of the turnbuckle method. It can be used to some degree as a "hold down," a "hold over," or as a "swing."

Advantages

The advantages of this type stroke control are numerous. It completes the volumetric requirements of the working barrel, no matter how small the volume of fluid the well flows into the bore. The large size working barrel in the well may be used to eliminate pulling and rerunning jobs.

A change of stroke is all that is needed to adjust the pumping rate to prevent pounding of fluid, obtain a more constant flow of gas, decrease the number of rod breaks, prevent tubing collar leaks, eliminate sand troubles, stop paraffin deposition, and decrease wear of pumps and accessories by keeping them lubricated.

In addition the control saves stuffing-box rubbers, eliminates hooking off wells, permits the pump to take out only the fluid that the well is capable of producing.



Stroke regulator for wells with polished-rod load from 2500 to 4500 lb. Threaded rod permits precision adjustment of stroke

These advantages tend to allow a more efficient and economical production. Such regulated production often increases the production of stripper and similar type wells.

Types of Regulators

The stripper well stroke regulator is for wells with polished-rod loads up to 4500 lb. or wells 500 to 2000 ft. deep. In this model the traveling beam is constructed of 11-lb., 7-in. I-beam with a standard length of 42 in. that pivots at the base like the old style stroke post. There are two flange-type castings with 3-in. diameter pins that bolt to the base of the I-beam. These pins take their bearing in a pillow block-type babbit bearing such as the swing post castings used universally today. This type of casting is readily available.

The well connection and the power connection to the I-beam are two steel "claw" castings that take their bearing from the flanges of the I-beam and can be put on or taken off by sliding them over the end of the I-beam flanges. Fitted into these castings is a 1¾-in. by 5-in. pin that connects another steel casting, housing a bearing. It is to these castings that the power and the jack rod lines are attached. The bearings are oil-bath bronze sleeve-type with oil seal containers. The castings have a small oil reservoir above the bearing that when filled should last for 30 to 40 days or can be filled with a long spout oil can without stopping the motion of the beam. These bearing castings have a large size eye so the rod line can be connected with a "C" link or combination rod line clamp. The casting that connects the rod line to the jack has a square nut set into it, through which passes the adjusting screw. The screw is made from 1½-in. cold rolled steel 42 in. long and has 6 threads to the inch. It is attached to the I-beam by an eye-type flange that bolts on to the top and bottom of the beam and is held in place by two set collars pinned through the screw. This makes it easy to take off in the field. The top end of the screw is square so the crank can be taken off when not in use. The casting that connects to the power side can be set at any desired position on the beam. It is held in place by two ¾-in. screws. This feature and the 240 changes that can be made with the screw (it being 6 threads to the inch and 40 in. of thread) give the operator a large range of length of strokes either as a multiplier or to reduce the length of the polished rod stroke. All changes can be made without hanging the well off the power.

Construction of the pump-stroke regulator for deep wells, 7500-lb. to 10,000-lb. rod load, is of heavier and stronger materials due to increased polished-rod load.

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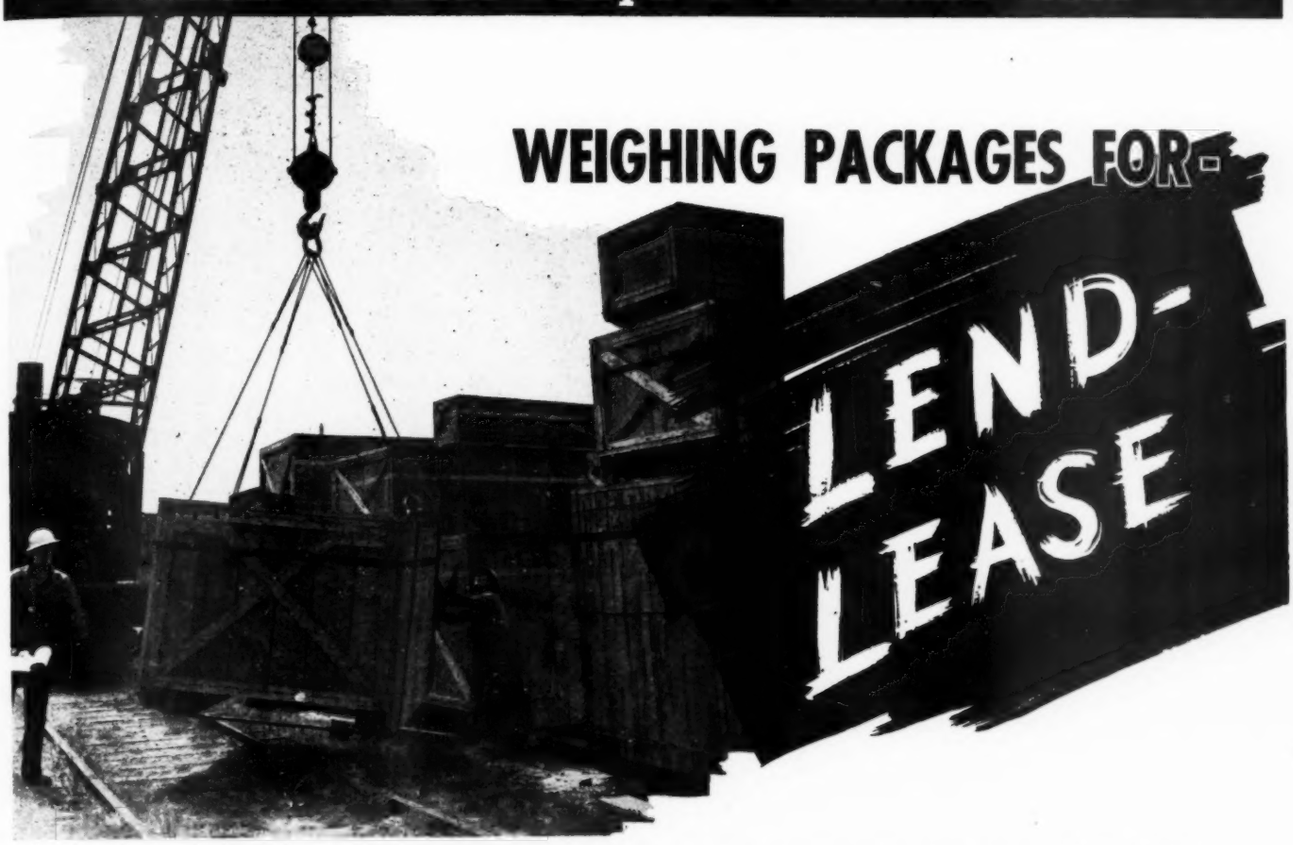
Author adjusting large-size stroke control for polished-rod load from 7500 to 10,000 lb., handling 133 bbl. fluid, 2000 ft. from power, ⅞-in. rod line, and ¾-in. rods. Reduced s.p.m. from 22 to 19

Martin-Decker Plays a Wartime Role--



WHEN a large California industrial plant was dismantled and prepared for shipment to one of our allies, the contractors were suddenly faced with the problem of weighing packages ranging from a few hundred to hundreds of thousands of pounds. It was important that the weights be obtained quickly and accurately; and as there was no railroad scales near, the problem seemed a difficult one until Martin-Decker was consulted. A Toolpusher Type Weight Indicator was furnished with curves for the various cranes used in handling the packages, and correct weights were obtained as routine lifts were made.

Martin-Decker Toolpusher Type Weight Indicators, the same instrument which oilwell operators use on their rigs every day, are in use by the hundreds in other industries.

To us, serving the war effort means serving the oil industry, and we are mighty proud of that privilege. We are proud also that the instruments which we have developed in over 16 years' experience and service to the oil industry are now recognized as essential to many other phases of the war effort.

MARTIN-DECKER WEIGHT INDICATORS are extremely flexible and fill many diverse needs. They form the basic elements in the two complete drilling control instruments—the Sealtite and the Drillogger. Where permanent records are not required, the three Toolpusher models cover the entire range of drilling needs.

The SPECIAL (capacity 630,000 lbs.) cares for the big job. The CLIPPER (capacity 480,000 lbs.) accommodates the medium job. And the SLIM HOLE (capacity 150,000 lbs.) handles the little job.

There is a Martin-Decker instrument for every weight control need!

The Clipper

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Reduction of Power Cost By Load Distribution

☆ Increased economy, improved operating conditions result from study and analysis of electric power distribution for field pumping

by J. R. Ashley

Division Electrical Engineer, Magnolia Petroleum Company

WITH the completion of the first oil well came the problem of lifting the fluid to the surface. Many types of lifts and pumps have been devised for this purpose; however, it is not the intent of the writer to pass judgment on the merits of any particular type. Herein is presented one solution of a problem arising from the use of modern equipment, and in passing, to mourn the exodus of some of the old familiar sights of the oil fields. Perhaps the best remembered is the old "Standard Rig" with its wooden derrick, bandwheel house, and belt and engine sheds. The old wooden walking beam, which creaked and groaned as it seesawed under its burden, is rapidly disappearing from the scene; giving place to things modern.

These "Standard Rigs" were among the first individually-powered pumping units. As an operating unit it was, in most cases, an adaptation of the equipment used for drilling the well. It served, and is still serving, its purpose without any material changes. More modern types of equipment have been developed, one of which uses an electric motor as a prime mover and a simplified speed reduction unit to supply power to a steel walking beam.

In years past economy of operation was not the order of the day. Fuel was taken from the well, either as gas or oil, without proration—a well simply made all the oil it could. Pumpers spent long hours "kicking off" an engine that had gone dead on a winter night, and oil was produced.

The application of electric power has introduced numerous changes. The pumper pushes a button or throws a switch and the unit is in operation. Proration limits the amount of oil produced, and thus the operating time of the wells is limited. "Fuel" is either purchased or generated in the field, and in either case, operating costs are a paramount consideration. In cases where but a few wells are involved, economical operation is comparatively simple, but large numbers of wells present a complex problem.

J. R. ASHLEY

was graduated from Virginia Military Institute with B.S. degree in electrical engineering, 1921—Employed by Texas Power and Light Company, Power Department, 1921-22—General Electric Company, Test Department, 1922-24—Texas Power and Light Company, Power and Engineering Departments, 1924-27—Employed by Magnolia Pipe Line Company in 1927 as electrical foreman, and was transferred to Magnolia Petroleum Company in 1940.

Most electrical contracts have a relationship between demand and kilowatt-hours consumed as the basis for computing costs. Thus, with control over either, savings may be made in all electrical operations. The problem of economical operation of the producing property under study did not become apparent until a major load, other than pumping, was to be shut down. The pumping load was incidental to the operation of a large motor-driven compressor station and was billed in the lowest cost bracket of the power contract. With the shutdown of this compressor station, a new power rate would become effective. This made a study of the pumping operations necessary.

One bank of power transformers served the compressor station; another served the company-owned transmission and distribution system. The pumping load of the lease is served from this system. Group billing was made by the power company from meters on each of the two banks of transformers. There are 95 wells with individual electric motors that vary in size from 5 to 15 hp. Each motor is controlled by a magnetic contactor, with a time switch for automatic operation. The wells are variously located over a 9-sq. mile area, and are supplied power by 17 banks of distribution transformers. In addition to the pumping load, there are offices, residences, warehouses, other industrial buildings, and a large machine shop to be supplied with power and lighting. There are also several thousand watts in floodlights. With the exception of the machine shop, this entire industrial load could be assumed to follow a regular cycle. The total connected load of the machine shop is in excess of 100 hp., and its demand fluctuates over a wide range.

Among the factors to be considered in planning the redistribution of the load were:

1. Variation in size of pumping well motors.
2. Overloading of distribution lines or transformers.
3. Load concentration on any branch feeder.

The first step in re-arranging the schedules was to determine the actual time of day each unit was in operation. Fig. 1 was developed from this study. This figure is divided into six charts, namely: Operating schedules, number of wells possible to be in operation (at any one time when on automatic operation), typical demand curve, relationship between actual peak and average demands, relationship between actual costs and theoretical minimum costs, and kilowatt-hours consumed.

Schedule of Operations

The schedule of operations (Chart 1, Fig. 1) shows that Well No. 39 operates from 8:00 a. m. until 9:30 a. m. and from 8:00 p. m. until 9:30 p. m., and Well No. 100 from 10:00 a. m. until 1:00 p. m., and so on. From this chart, by counting the blacked-out segments in each hour, Chart No. 2 was developed and this ragged curve obtained. The number of wells in operation was found to vary from a minimum of 7 to a maximum of 69. Here was the factor over which control could be maintained. It is necessary to pump the wells a certain number of hours daily in order to obtain production, but, as all wells were equipped for automatic operation, the number of wells in operation at any one time could be brought to an average.

Chart 3, Fig. 1, "typical day's demand," was made from a development

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PREFORMED ROTARY LINE

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J. S. Abercrombie Co.

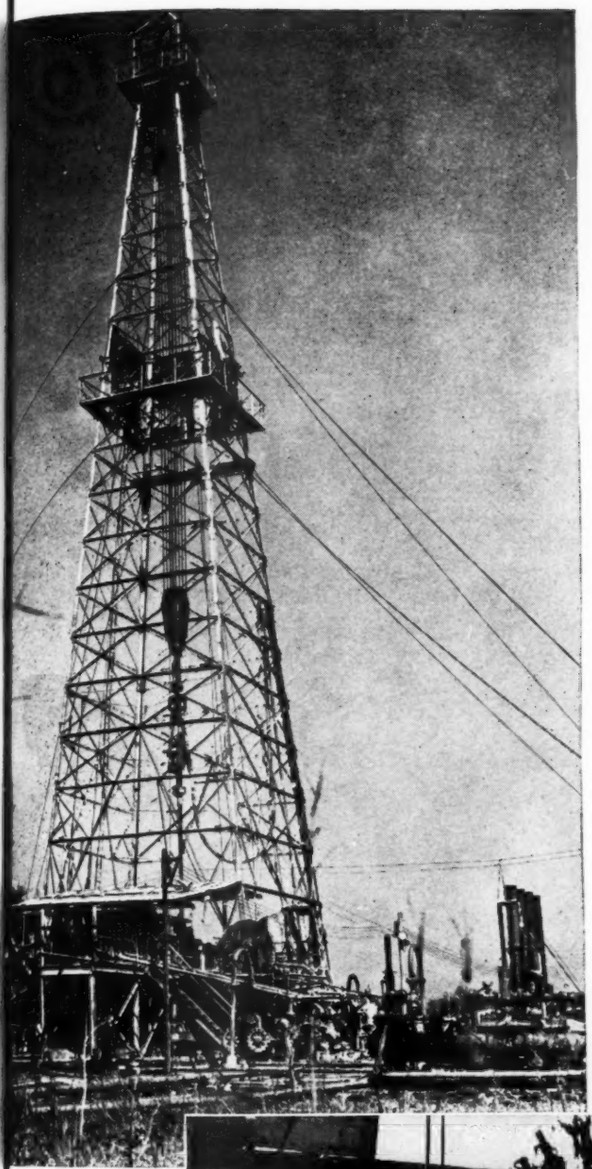
drilled the 1-B McDonald to

14,378 ft.

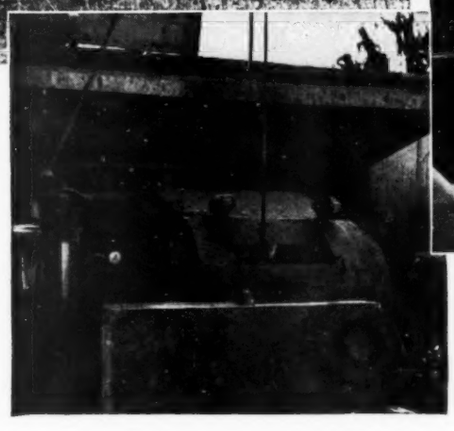
...a new Texas record and the 3rd deepest well in the world!

In addition to setting a new Texas and Gulf Coast depth record, this celebrated J. S. Abercrombie operation in the Old Ocean field was remarkable for its speed. Credit is rightfully shared by the management, the drilling crews and the equipment. Notable performance among the latter was contributed by four patented Abercrombie fluid piston slush pumps and two 2500-ft. Preformed Yellow Strand IWRC Rotary Lines. The Yellow Strand wire line on the rig when total depth was attained made 44 round trips and itself set a new Abercrombie record for ton-miles. Remember . . . Preformed Yellow Strand also was the choice of Fain Drilling Co. when Continental's Proctor No. 1 reached 14,582 ft. in 1939. That's *two* of the three deepest holes in the world for Preformed Yellow Strand. Need we say more?

BRODERICK & BASCOM ROPE CO., St. Louis
Houston Branch: 1311 Palmer St.



Above, the Abercrombie rig that drilled the new Gulf Coast record for J. S. Abercrombie Co. and Magnolia Petroleum Co.



Above, the rotary table and one of the B & B reels.

At left, the drawworks with Preformed Yellow Strand showing.

Below, these members of the drilling crew have a right to be pleased with the smooth, speedy job they turned in.

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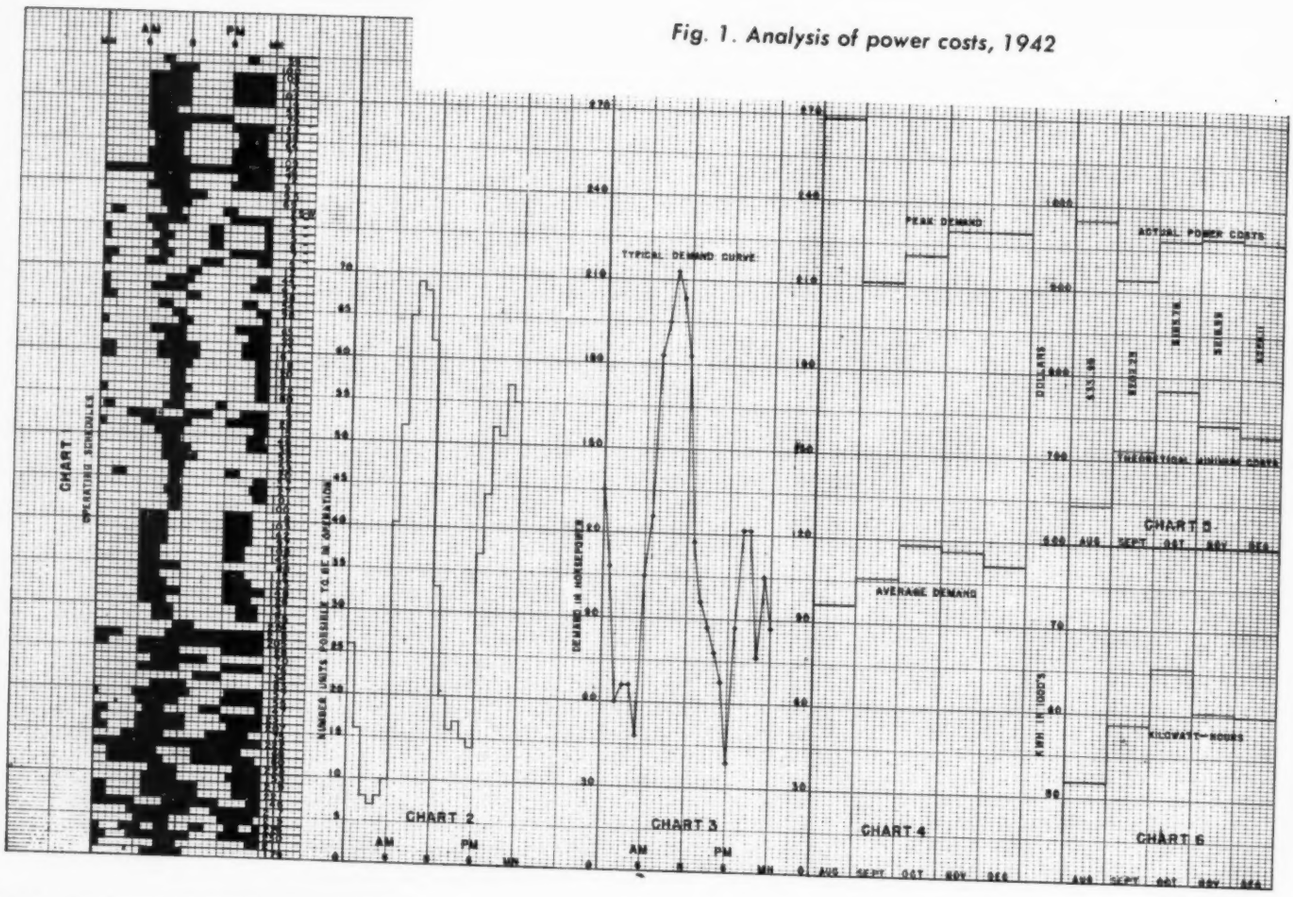

Fig. 1. Analysis of power costs, 1942

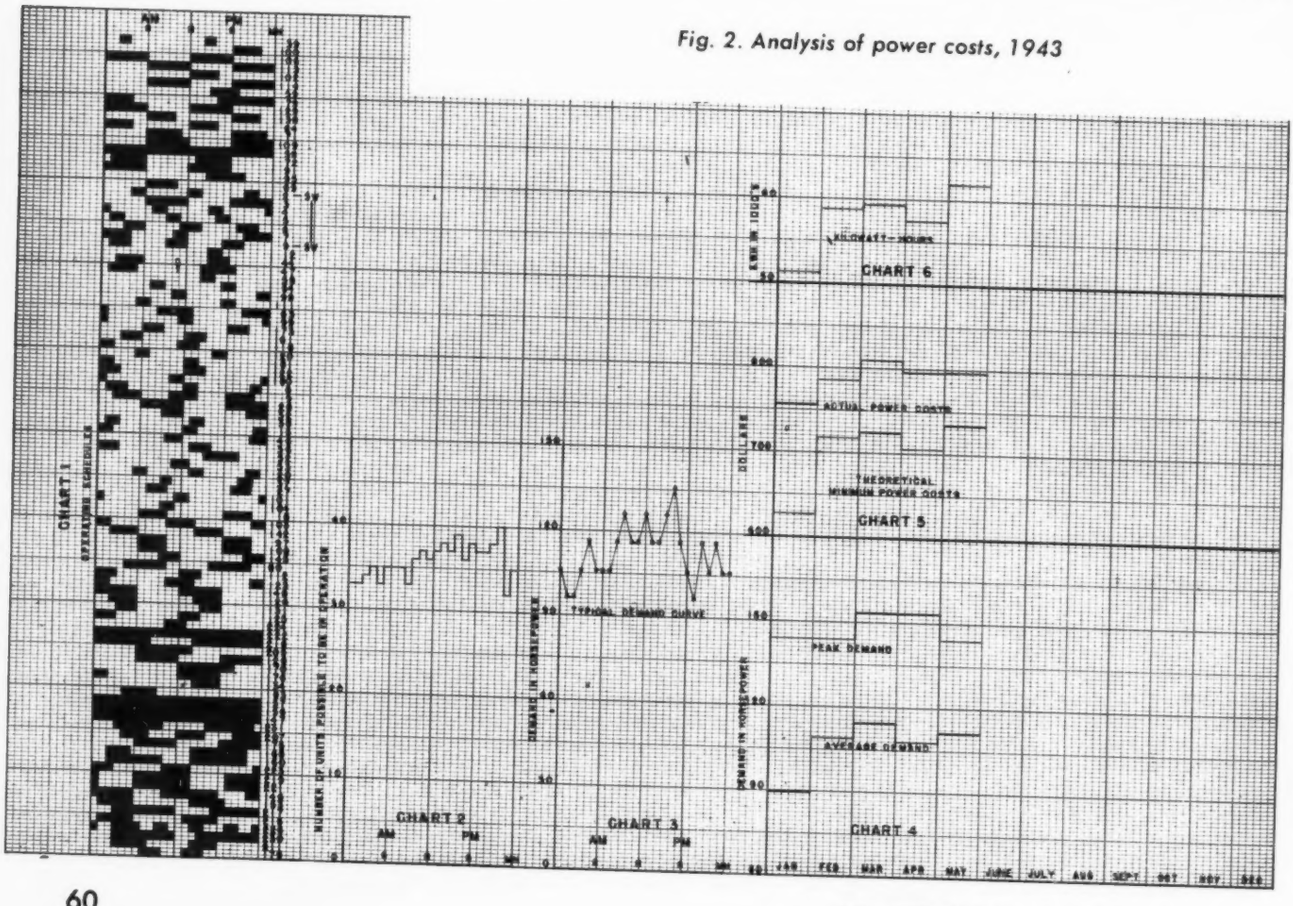

Fig. 2. Analysis of power costs, 1943

THE DESTROYER ESCORT, one of the newest anti-submarine weapons, compares in size with a Destroyer. Heavily armed, it mounts dual purpose cannon, 20-mm. anti-aircraft guns, and carries a big cargo of depth charges.
Hughes Tool Company's many years experience in pouring steel castings for Oil Industry equipment is also doing its part to speed the production of huge propeller struts for Destroyer Escorts.
Hughes is turning out numerous other products for the Army, Navy, and Air Forces *in addition to tools for the essential oil well drilling industry.*

of the demand chart. A comparison was made between this curve and the curve representing the number of wells in operation. There was such a marked similarity between them, it was decided to disregard the variation in the size of the motors connected. This decision was also influenced by the lack of control over the fluctuating demand of the machine shop.

In order that no part of the distribution system should be subjected to an overload, the wells were grouped according to the banks of transformers serving them. A time schedule was inaugurated for each group and the various groups were then balanced over the entire system. It may be added, that each well was carefully counter-balanced, using a splitcore ammeter, when it was put on the pump; and that a periodic balance check is a part of the maintenance schedule. More wells will be added from time to time, and overloading of lines or transformers must be avoided. Load concentrations had already caused bad voltage conditions in parts of the field. This becomes more apparent when it is realized that oil-well pumping loads seldom have better than 50 percent power-factor; also, any amount the peak load could be reduced would give the two-fold advantage of decreased cost and the addition of an equal amount of load without further burden on the transmission system.

Charts 1 and 2, Fig. 2, show the first new operating schedule put into effect in December, 1942. Definite improvement was immediately seen. From developments of subsequent demand charts, changes in this schedule, which were obviously necessary, were made. By the time the new contract became effective a satisfactory demand curve had been obtained. It is, of course, impossible to hold the demand to the average value, but the improvement can be clearly seen in the demand charts Figs. 3 and 4. Changes occur in the characteristics of the individual wells, and no inflexible schedule can be set up. Pumpers are instructed regarding the hours to be used when increasing, or decreasing, the pumping time of their wells, For this reason, periodic checks must be made and revisions of the overall schedule worked out. These revisions require little time and hold costs as low as possible.

The charts on actual costs and theoretical minimum costs, Figs. 1 and 2, graphically illustrate the benefits that have been derived from this study. The actual cost, Fig. 1, was obtained by applying the metered demand and kilowatt-hours consumed in the forthcoming new rate. Theoretical minimum costs, Figs. 1 and 2, were determined by applying the average demands and kilowatt-hours used in the new rate. The average demand was found by dividing the kilowatt-hours by the number of hours in the billing period, and converting the quotient into horsepower. The wide separation between actual costs and minimum costs in Fig. 1 is greatly reduced in Fig. 2. The January, 1943, curves are based on an estimated kilowatt-hour consumption. The meter was dead for a considerable portion of the time, and, on the basis of the months preceding and following, it appears that the estimate was low. This accounts for the erratic curves of this period.

Results of Study

The direct results of this study and its application over a five-month period have been:

1. A saving of 17.96 percent per month in the power costs.
2. Better operating conditions for all motors, with a higher sustained voltage throughout the field.
3. A permissible increase of 80 percent in the present load without increasing the established peak burden on the transmission system.

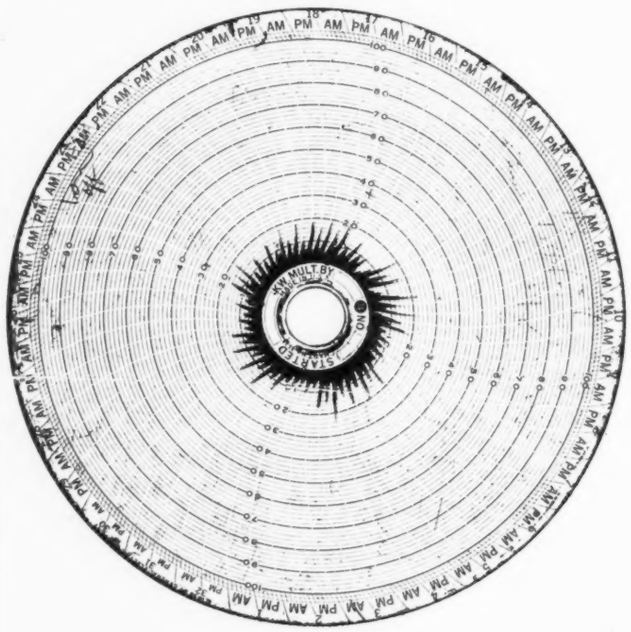

Fig. 3. Thirty-day demand chart taken before load redistribution

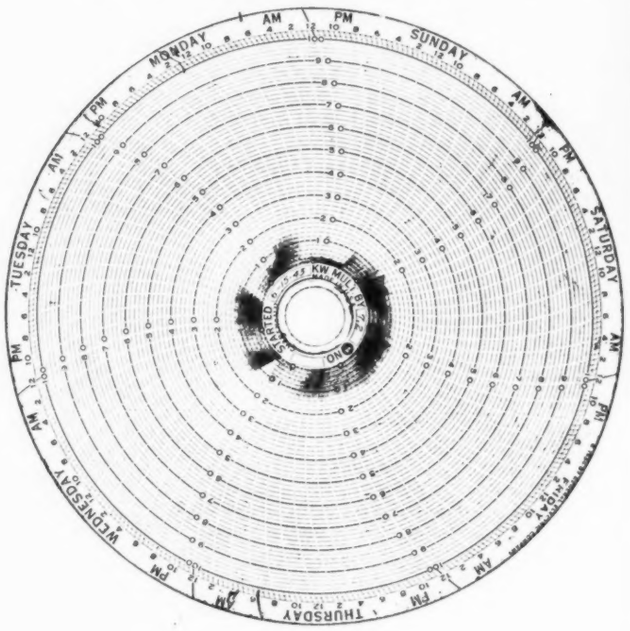

Fig. 4. Demand chart after load redistribution; showing also load dumping by power interruption

WARNING!

PRESSURES EXCEED 3000 LBS. BELOW 7000 FEET

SWITCH TO CAMERON 6000 LB. TEST DRILLING CONTROL UNITS

When a well starts "unloading" from below 7000 feet, it's too late to replace drilling control units of too little capacity!

Since the normal potential bottom hole pressure of any well passes the 3000 lb. mark below 7000 feet, the operator who drills beyond that depth without 6000 lb. test drilling control units, regardless of mud weight, is inviting trouble.

To date, not a single well equipped with Cameron 6000 lb. test pressure-operated drilling control units has suffered a blowout due to failure of the control equipment, which clearly establishes it as the industry's most dependable safeguard against destructive well pressures.

To protect irreplaceable drilling machinery and to conserve valuable reservoir pressures, operators on wells projected below 7000 feet are urged to use Cameron 6000 lb. test pressure-operated drilling control units—Cameron Type "SDA" Blowout Preventers to seal around pipe in the hole; Cameron Type "DV" Gate Valves to seal the well bore while pipe is out of the hole; and Cameron Type "DV" Flowline Valves to guard against loss of control through the flowline.

CAMERON IRON WORKS, INC.

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Oil Companies Respond to Plea for Scrap Metal

☆ Many instruct superintendents to locate immediately all scrap on leases and await arrival of Army

by Major Alfred R. Teter

Co-ordinator of Salvage, Eighth Service Command

OIL companies in Texas, Arkansas, Oklahoma, Louisiana, and New Mexico, to whom the Eighth Service Command sent letters appealing for scrap iron, steel, copper, brass, and bronze, are responding wholeheartedly

Major Alfred R. Teter, who has just been appointed Co-ordinator of Salvage for the Eighth Service Command

by offering every coöperation and facility at their disposal, according to replies reaching the salvage office daily.

One oil firm in Texas wrote that they were instructing their field superintendents to locate immediately all scrap on their leases and to await the Army's arrival.

"We have about 15 to 20 tons of scrap we would be glad to give to the Army," phoned another.

"If we can be assured that this scrap is being collected by the Army for the Army, then we will be happy to permit Army personnel and trucks to visit our leases," an Arkansas oil producer stated.

Another oil company not only agreed to give its scrap to the Army but even gave exact directions for finding its metal collections.

As the industry uses heavy machinery and equipment, it is believed that by communicating directly with oil producers, large amounts of scrap metal will be collected that ordinarily would not reach the mills.

In normal times steel plants obtained an ample supply or reservoir of scrap from the very articles they manufactured. The curtailment of civilian item production, however, has correspondingly reduced an equal amount of resulting scrap; but nothing must prevent the mills from maintaining a steady and continuous flow of materiel.

Unfortunately for the nation's steel program, many obstacles have retarded the collection of scrap metal. The floods in Arkansas, Oklahoma, and other Southwestern states, the weather handicaps in the East, the rationing of gas, the freezing of trucks, the shortage of manpower, the drying-up of non-recurrent scrap in homes, farms, railroads, and automobile graveyards, with the latter's 1943 quota reduced from 2,500,000 tons to 1,500,000 tons of scrap iron and steel, the late movement of iron ore on the Great Lakes, the delay in the construction of blast furnaces—all these have contributed to an acute scrap metal situation.

Despite these conditions, the Army is striving continuously to obtain scrap copper, brass, bronze, iron, and steel, the metals essential to constant production. The response of the oil industry indicates its complete understanding of the Army's appeal. —— ☆ ☆ ☆ ——

Soldiers of the Fort Bliss Salvage Collecting Detachment pushing a flat car loaded with scrap metal obtained in its scrap campaign at Carlsbad, New Mexico

Whither Are We Bound?

PART 2

PETROLEUM ENGINEER Exclusive Feature

by R. G. Lovell

Development Engineer, Hancock Oil Company of California

WE believe it to be self-evident that the highways of the future will, of necessity, need to be of radically different design, as they are to serve radically different types of transportation. One type can be defined as the light, high-speed pattern adapted to cars with seating capacity limited to, say, six people; another to serve group passenger needs of buses up to 50 persons each.

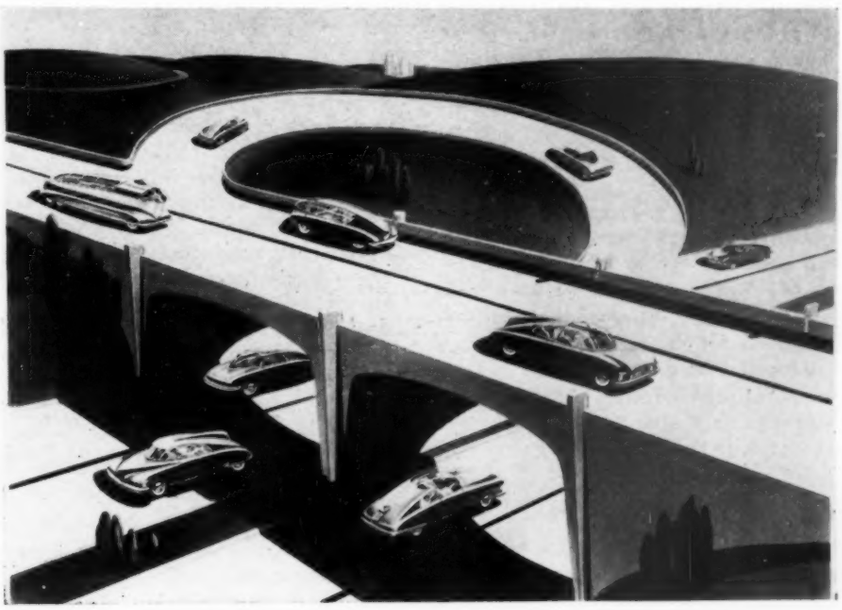
To provide for goods transportation, where speed is a prime requisite, we can use the same roadway as that used for most passenger service; but this road will not adequately serve for slower moving, heavier loads. Not only must different materials be chosen for its construction but, in many cases, its route is likely to be altogether changed. The route to be followed will not be dictated, as some may believe, by location of population centers but rather by the necessity of maintaining a high ratio between weight of load and weight of power plant. The thing works out something like this: We are prepared to sacrifice some degree of road speed in order to attain high load weight per unit of transport vehicle. To support this heavy load demands a heavy chassis. If, now, we provide a power plant of sufficient power, even by changing gear drive ratios, to pull this heavy load over the grades of our light-weight, high-speed highway, we are going to lose some of our revenue-producing, dead-load capacity on level road or low grade.

Therefore, we will cut a leaf out of railroad's design manual for right-of-way. This consists of adapting the length between points of different grade so that a given maximum gradient percent will not be exceeded. The maximum is determined by compromise between motive power and load tonnage. This principle has not changed over the years nor is it likely to change. As locomotives of greater horsepower have been built, more load has been given them to pull—but without particular change in the maximum grade percentage. It should be noted in passing, however, that one of the ways by which the railroads met the challenge of truck and bus competition consisted of increasing curve radii so that their larger locomotives could haul selected freight and passenger loads at higher speeds.

Right here a voice can be heard muttering, "yeah-but to build such roads would cost too much." If the Union Pacific Railroad, for example, had been guided by "yeah-butters," the development of the high-speed streamlined passenger train would have been retarded no end. By this means, as well as by other progressive ideas, the railroads were able to change their fiscal condition from loss to profit. Perhaps a better example is the San Francisco Bay bridges. These had been talked about for years; not only was their engineering practicality in doubt but, further, to finance their cost was considered impossible. These bridges have been found to be entirely practical from the engineering standpoint and the toll revenue from the very beginning of their operation has been so much greater than the calculated figure that reductions in toll rate have been made and the bridges bid fair to pay out in much less than the calculated period. If, therefore, proper highways can be built to serve us better in the transportation of our merchandise and ourselves, their cost can and will be absorbed by the increased volume of business and the lower handling cost.

It will be easy for the afore-mentioned "over-vitaminized" imagination to visualize the railroads completely out of the transportation picture but this definitely will not take place any more than highway transportation was able to erase rail transportation. The improved highways and vehicles will be just another evolutionary step toward the attainment of the objective, the widest practicable distribution of the results of our brains and energy.

At the time when truck and bus transport began biting deeply into railroad revenues, railway management actually spent much time and money in the effort to support a claim that highway transport should be taxed to the point where their tariffs would be equal to those charged by the railroads. The argument was used that, whereas the railroads had to buy and maintain their own roadbed, the trucks and buses were operating on the public highways, the use of which cost them nothing. The main points of this argument were altogether fallacious inasmuch as the railroads, as a whole, had been given, as



Highways of the future will need to be of different design to serve different types of transportation
(Photo courtesy Ethyl Corporation)

a development aid in the beginning, not only their first rights-of-way, but also had been given land by the Federal Government, bordering on their rights-of-way, the total area of which is understood to be something like that of the New England States plus half the Atlantic seaboard states. It was true enough that they were burdened with the expense of maintenance of roadbed but this was equalized by rises in the gasoline tax. The actual case was that the trucks and buses were able to offer a better service at a lower price and, therefore, were being favored with the short and medium haul freight and passenger business. When railway management came to realize that the interests of the country at large were paramount to the payment of dividends to current holders of railroad stocks, that there was nothing to prevent railroads from engaging in the business of transportation by truck and bus, and that improvement in their facilities and service might be expected to bring back to them much of their lost business, the whole proposition equalized itself.

The writer feels that he is likely to be criticized for departing from his subject in presenting these thoughts on transportation, but is confident that the presentation is justified by that which he thinks is an obvious need: a relatively complete discussion of the many side issues that are bound to have a profound effect upon the petroleum industry as a whole and upon the fortunes of individuals engaged in the industry. The industry, as a unit, cannot help but prosper for we have the fuels to power and the oils to lubricate the wheels of transportation whether they be rubber-tired or of steel.

Types of Engines

Types of engines to be discussed are:

(1) Standard, carburetted, air or liquid cooled, spark ignited, non-rotary, multi-cylinder.

(2) Liquid fuel injection, air or liquid cooled, compression ignition, designed for direct drive through reduction gears.

(3) Same type as (2) but designed to drive through intermediate electrical units.

(4) Rotary, carburetted, air-cooled.

(5) Rotary, compression-ignition, arranged for direct drive or through motor-generator set.

(6) Reciprocating, uni-flow, condensing steam engine adapted either for direct drive or with electrical units.

(7) Steam turbine.

(8) Gas combustion turbine.

The Standard Aspirated Engine

To make effective comparison we will set up as a horrible example a standard, 8-cylinder, water-cooled engine with a compression ratio of 6.5 to 1, which, with its cooling system, weighs about 1000 lb. and develops some 125 hp., only a fraction of which is realized as tractive effort to propel the vehicle along the highway. The remainder is consumed in friction, internal tire stresses, and overcoming wind resistance. This power plant has been burning gasoline at an average rate of one gallon for each 13 miles it propelled a total weight of approximately 4000 lb. in 15 min. The gallon of fuel contained about 123,000 B.t.u.—some 50,000 of which went out the exhaust pipe, approximately the same amount was dissipated in the radiator and by direct radiation from the engine, and about 13,000 was lost in overcoming friction including tire torsion. This leaves only 9800 B.t.u. of actual power, or 8 percent of the total that was in the gasoline. Not a very pretty picture for a nation that prides itself on its efficiency!

Corrective Measures

It has already been brought out that many of the corrective measures have been known for a long time but, for reasons also given, these measures would have been punitive in application as well as corrective. The cessation of automotive manufacture for civilian use is proving to be a blessing in disguise. It is removing the chief handicap to a correction of this otherwise inexcusable inefficiency in addition to teaching us to take proper care of what we have.

Many in the petroleum industry have long held that any extensive steps to improve the fuel mileage of automotive equipment would increase the overproduction-of-crude-oil problems. I think they are looking through the wrong end of the telescope. If the instrument were reversed they might get a view of some 500,000,000 Asiatics being taught the joys and utility of petroleum-product-propelled vehicles. The magnitude of this potential market off our Pacific shores baffles the imagination, and the degree in which we participate therein, as a nation and each of us as individuals, is largely a matter of how we conduct ourselves during the struggle necessary to demonstrate the supremacy of Anglo-Saxon and kindred ideals of honesty, decency, and justice, how firmly we join our allies in taking steps to insure the maintenance of this supremacy and, after these things have been accomplished, how energetically we go after the business.

Weight of the New Engine

No one needs any imagination-stimulating vitamins to get a mental picture of the automobile engine of the future. Enough facts are in hand to predict something of its weight and size and the implications thereof. We already know that if we increase the compression ratio to something like 10 to 1 instead of the present average of 6.5 to 1 and provide the engine with a gasoline of 100 plus-octane number, the potential power is raised to about 150 percent of the original.

We have also learned that a non-rotary engine can be much more efficiently cooled by the evaporation of a small quantity of water into steam than by the present method of circulating a relatively large quantity of water and merely raising its temperature to about 180°F. The fundamental purpose of the idea is to take advantage of the latent heat of vaporization of water into steam. An explanation of both latent heat of vaporization and specific heat is in order, particularly as they apply to the problem in hand.

The principal purpose of cooling the cylinder walls of an internal-combustion engine is to make lubrication effective. Any reduction in temperature below the point necessary to accomplish that purpose is not only wasted energy but, in addition, reduces the efficiency of the engine. Current automotive practice is to circulate water in such amounts that it leaves the engine at a temperature not in excess of 180°F. Each pound of this water on its way over the surfaces being cooled absorbs 1 heat unit (B.t.u.) for each degree fahrenheit that its temperature is caused to rise by this heat absorption. The same rule applies in reverse as the heated water is cooled in the radiator. The designer of the cooling system, naturally, tries to make each unit of area in the engine jacket pass into the water as many heat units as possible in a unit of time and the radiator surface dissipate as many B.t.u. as possible in a unit of time. He is limited, however, by the fundamental law of specific heat outlined above.

On the other hand, if the area of the water passages and the amount of water in circulation are reduced in the correct proportions, the water must and will absorb more heat until the boiling temperature, 212°F. at sea level, is reached and the water is converted to steam. For every pound of the water that is converted to steam, 970 B.t.u. are removed from the surfaces to be cooled instead of 100 B.t.u. that would be the case with the large quantity of water entering the jacket at 80°F. and leaving at 180°F. The radiator must, of course, be of such design and capacity that it can reduce the temperature of the steam by a few degrees so that it will revert to water and then cool the water to some predetermined point, say 100°F.

(To be continued)

☆ ☆ ☆

Petro-Chem

Presents

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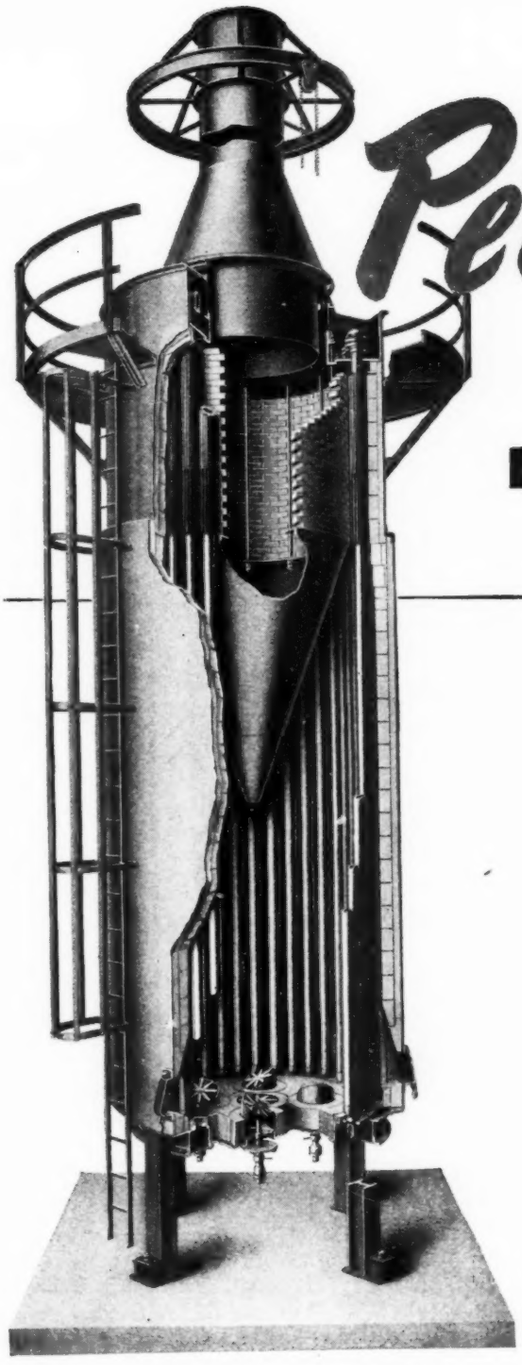

ISO-FLOW* FURNACES

save 30 to 50% in Critical Materials

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Servicing Oil-Well Pumping Equipment

PETROLEUM ENGINEER EXCLUSIVE Feature

☆ Few positions in the oil industry require greater knowledge and skill than that of the "oil-well pump service man"

by L. E. Kesselman

Service Manager, Fluid Packed Pump Company

Abstract

THE production of crude oil by a few men skilled in the art and science of pumping wells has become a widely recognized profession. Included in this specialized field is the small group of technical men known as "pump-men" who must have a combined knowledge of the practical as well as the engineering problems encountered in all types of pumping oil wells. Few positions in the oil industry require more of a thorough working knowledge of all the complicated phases of oil production than that of the "oil-well pump service man."

Introduction

To maintain the production of a pumping oil well always has been an engineering problem. Ever since the pioneer producers tapped this great source of energy, the oil industry has relied upon the skill, ingenuity, and inventive ability of men technically educated and trained in the work of maintaining the pumps to lift the oil to the surface. Once pumps are developed and installed in the depths of the wells, these high-precision pieces of equipment require periodic inspection. The production and efficiency of pumping wells depend largely upon the proper maintenance of correctly proportioned pumping equipment. In order to maintain a necessarily high rate of efficiency, it is evident that a fully qualified and competent man will be required to provide this service in the field—in fact, at the individual well installations.

There are certain facts that should be understood by all who concern themselves with the production of oil, whether they are in the industry or have reason to familiarize themselves with this phase of our national security. Numerous variable factors, many of which remain unknown quantities until pumping operations are well under way, contribute to make positive the well-known fact that no two wells have like conditions and therefore no two pump installations are exactly alike. Every oil well to be pumped must be considered as a separate engineering problem. Such is true also of the service and maintenance of pumping equipment. Even here, there is the problem of ever-changing conditions during the life span of the well's productive period.

LYLE E. KESSELMAN

is widely known among California oil men—In 1920 he established a branch plant for Kesselman and Company, of Butler, Pennsylvania, and Parkersburg, West Virginia—After the Santa Fe Springs activity in 1925 he entered the drilling and production phases of the oil business and has continued active in all lines since—As well as drilling his own wells, he gained wide experience with other firms as engineer, toolpusher, and drilling and production superintendents both in California and Texas—His well-rounded oil career also includes two years each in the technical and manufacturing departments of Shell and Associated.

True production efficiency in pumping wells cannot be maintained by merely assuming the value of certain factors. It may be necessary to calculate the value of some factors in the case of new installations in new wells, but it is definitely necessary for the production man and the pump service man to obtain specific information on the condition and pumping factors of each well with reasonable accuracy before making the pump installation. To provide for even the lowest permissible "overall efficiency" in pumping operations, the pump service man must be able to deal with the problem both from the engineering standpoint and that of practical application. To do so competently requires that the service man be well trained in both and be able to apply readily the combined principles with complete effectiveness.

This work cannot be shared by just anyone in the industry. Yet, it is not the monopoly of a certain group. Nor is it a patented vocation granted only to those possessing degrees and titles from colleges and universities. The oil-well pump service man needs only to practice certain engineering precepts in oil production, apply practical operating methods, and above all have a thorough and technical knowledge of the construction, choice of materials, inspection, parts, operation, installation, maintenance, disassembly, reassembly, transportation, proper selection, field care, and use of oil-well pumps to become one of the most important "key" men in the vital business of producing crude oil.

Duties and Responsibilities

Pump engineering principles must be extended to include the selection of materials, specifications, operating conditions, and inspections. These studies of general or specific recommendations for the proper installation must be conveyed to the operating personnel either in the field or in the general office, or both, by the oil-well pump service men. Close personal contact with all who have to do with the pumping operations must be maintained regularly. The service men must therefore "make the rounds" on a fairly well-defined schedule and in addition, be on a 24-hour call service as pump "trouble-shooters," which may or may not include making on-the-spot maintenance repairs or supervising the actual installation of the pump.

As might be expected, no two companies handle their oil-well pump requirements in exactly the same manner, and in many companies the methods differ even in the various divisions; however, all systems fall within one of the following general types:

Type 1. A dual structure in which the operating personnel and the production engineering personnel are independent and separate parallel organizations within the company. In this type the junction between the strictly engineering and the actual operating is

Uncle Billy Smith and his crew had quit work for the week-end.

Day after day for weeks, their crude tools had been pounding into the sand and shale of Oil Creek, near Titusville, Pa. They were down 69 feet, and still no strike of oil. So Uncle Billy went over on that Sunday afternoon, back in 1859, to do some figuring. Peering into the drill hole, he noticed what appeared to be water near the mouth. With an improvised dipper, he drew up some of the liquid and poured it on the ground.

It was black, gleaming crude petroleum! And Uncle Billy's dipper now is symbolic of the thousands of American producing wells that have been drilled since that historic Sunday. *They have changed the living habits of the whole world, and already have added a total of 32 billion dollars to American wealth alone!*

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at the general office where final decisions are made; however, frequent contacts between field production men and subordinate engineers must be had if much is to be accomplished. The success of pumping operations when particular pumps are necessary for efficiency depends upon the pump man's ability to bring these two operating units together in such a manner that decisions concerning specifications and recommendations can be turned in to the general offices, where then the pump service man must again present the facts in full detail before an installation order is given.

Type 2. The production department that employs a standardization engineer, but does not recognize such engineering as a full authority for all decisions. In this type of structure the engineer usually functions in an advisory capacity on specially assigned production and pumping problems. Generally, provision is made for the production superintendent to pass on all equipment to be used in his district. The pump man must maintain close contact and work with both of these men as well as with their subordinates in the field.

Type 3. A combination structure in which operating and engineering personnel form a single organization. This plan makes the engineers responsible to the superintendent of their respective districts. The superintendent is responsible in turn to the superintendent of the next office in authority. This carries through to the general office, where the general superintendent or production manager, assisted by his office engineering staff, supervises the entire production division. In this type, engineers may act as assistant superintendents. The pump service man is required to "follow through" from department to department when requested to do so. This means that he must be familiar with each and every successive person in authority from the pumper to the general production manager. This sort of liaison work is diplomatic in nature and a thorough working knowledge of the many production problems is a prime requisite. Actual field experience is considered to be of vital importance. Training in the handling of this type of organization is impossible to attain short of years of experience and requires that an up-to-date study of new and current problems and equipment be maintained.

Type 4. Independent operators having from one to many wells generally maintain a producing department patterned after one or a combination of the above-described types. Frequently the pump service man must act as a production equipment engineer for the smaller organizations. Here the pump man must have sufficient experience to appreciate the difficulties generally encountered in the production of oil with inadequate surface equipment due to limited capital investment.

Service Men Are Specialists

It has been said that "the service life and operating efficiency obtained from an oil-well pump depends upon the proper selection as to type and size for a given well condition; then upon the care used in the original installation and subsequent maintenance." It is therefore obvious that the pump man must be a specialist in the art of pumping oil wells. He must be constantly alert to the problem of reducing lifting cost through the close inspection of production and equipment methods and records. From his experience in the daily contact of oil-well producing operations he is generally able to advise the best methods necessary to maintain pump equipment at a minimum cost.

It is the general practice of oil operators to maintain a "pump house or shop." Here worn pumps are brought in for inspection so that parts can be replaced and the re-fitted pump made ready for further service. Many of the larger companies employ a pump repairman whose duties are to clean up, re-fit, and keep records of all new and used pumps. He depends upon the field pump service man to supply him with all pertinent information concerning regular and special types of pumps. This includes the recommended inspection, construction, and assembly details. Most pump repairmen prefer to wait for a scheduled call of the pump service man before making a thorough inspection of the parts. The specialist, after making the inspection, then recommends the proper servicing of the pump and the necessary parts are ordered for this purpose. Replacement parts most frequently needed are usually kept in the pump house. It is the duty of the service man to see to it that this emergency stock is properly kept up so that pumps may be repaired "on-the-spot."

The field service man is often called upon by the purchasing and stores departments of the oil companies to interpret certain pump engineering data for cost records, charts, and graphs. He is also required to submit information for the use of the various purchasing agents of the oil companies. The oil companies insist that this type service is most important for the control of their purchases of oil-well pumps and parts.

In most instances the territory covered by a field service man is large. An example of the scope of coverage by at least one pump company organization is cited. District No. 1: Pump service man contacts (in the period of a month) not less than 200 oil companies having a total of some 3600 producing oil wells. Personal contacts during this period will usually run into the hundreds. Due to the distances between the fields and scattering of the wells, the average number of miles driven to service these accounts ranges from 2500 to 3500 per month. This represents only the routine coverage of the territory and does not include any of the special or emergency trips required to service pumps. To complete the brief survey of the coverage task embodied in duties of the service men for this concern, it is pointed out that District No. 1 is only one of five of such service assignments required to cover a producing area in which the overall distances run into several hundred miles and there are over 18,000 producing oil wells to be serviced.

☆ ☆ ☆

Noise Abatement in Diesel Engines Problem of Design

Noise in Diesel engine exhausts is caused by longitudinal oscillation at acoustic velocities of gases, which snap like a teamster's whip unless checked, whereas noise in Diesel blowers can be silenced by eliminating easy modes of vibration, according to Ralph L. Leadbetter, of Burgess Battery Company, Chicago, Illinois.

Leadbetter addressed the Diesel Engine and Fuels and Lubricants Meeting of the Society of Automotive Engineers in Cleveland, Ohio, recently, describing experiments that reveal the acoustic shortcomings of Diesel engines and indicate corrections.

He warned that application of a braking effort to gas oscillation in the exhaust line may interfere with proper scavenging and recommended a "snubber" having a volume of approximately 40 times the volume of gas discharged into the exhaust pipe with each pulse from the engine.

Silencing the air intake was said to call for preventing noises due to vibration of housings and for quieting the air inlet opening, the scavenging pump, or the blower. Leadbetter suggested the blower housing could be laminated as an expedient, but should be constructed either in sections or with ribs cast integral with the surfaces, to prevent ringing.

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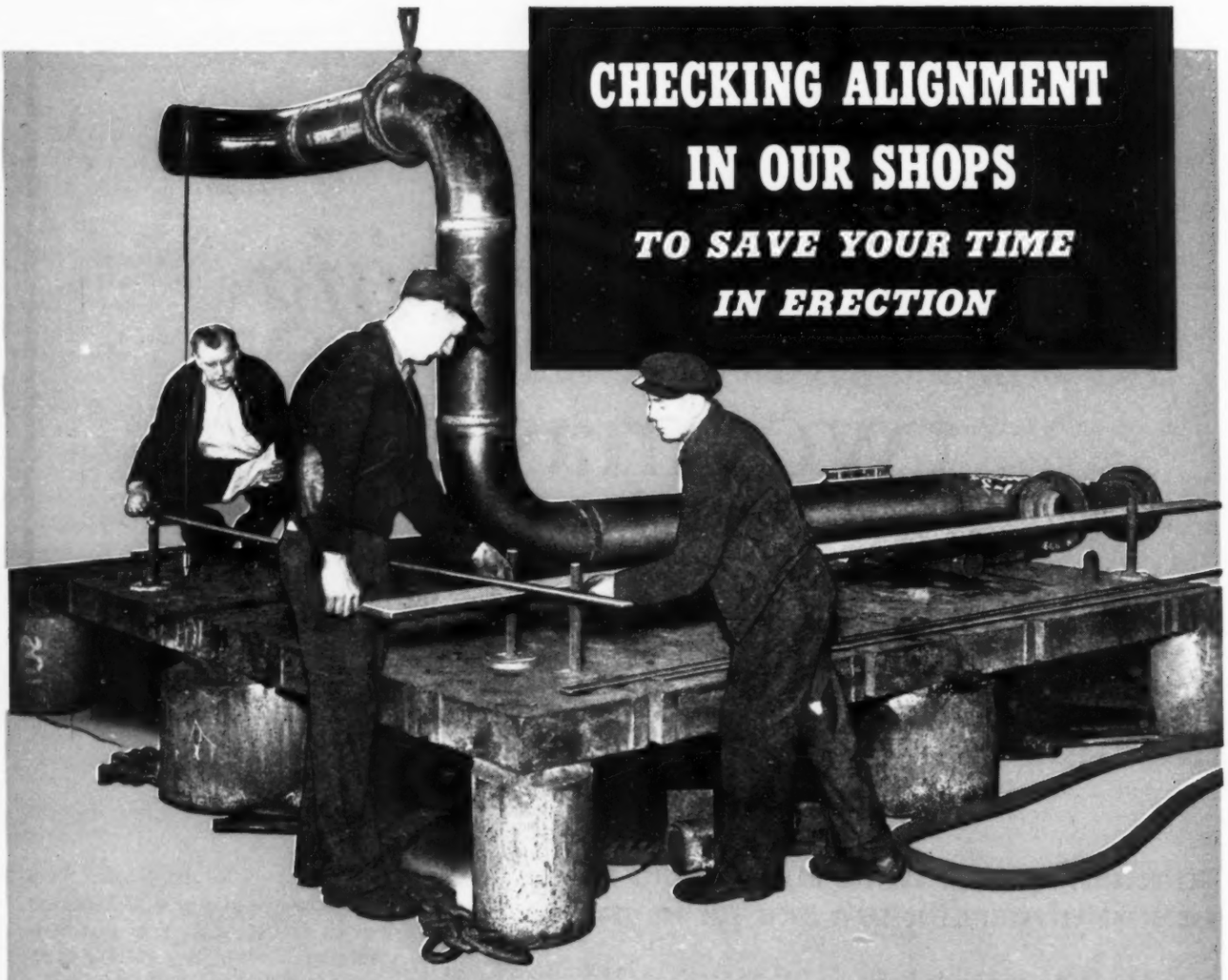

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Sulphur Products From the Aluminum-Chloride Complex Obtained in Refining High-Sulphur Gasolines[1]

☆ **Laboratory experiments determine possible utility of sulphur compounds**

by I. I. Tsyganok and L. A. Vanyukova
(Ishimbai)

THE problem of desulphurizing distillates obtained from crude oils high in sulphur content is not a new problem, but is becoming more important with time as more and more oils high in sulphur content are being produced and the quantities of distillates produced from these crude oils and their consumption is on the increase. The existing methods used in the desulphurization of distillates have many disadvantages of which the disposal of the bulky waste products obtained in the refinery is a problem of major importance.

The new methods developed by the staff of the TSIATIM for the removal of sulphur compounds from gasoline by treating the gasoline with aluminum chloride unquestionably soon will be generally accepted by the refining industry for treating gasolines high in sulphur content. Therefore, it seemed of interest to investigate the possibilities of utilizing the sulphur compounds separated from the complex materials obtained as the result of the use of aluminum chloride in the refining of gasoline. Experiments under laboratory conditions thus were initiated; they had for their purpose the preparation and study of these complex compounds of aluminum chloride and sulphur-containing substances.

The complex compounds were prepared by treating gasoline previously treated with caustic, with 3, 6, and 9 percent aluminum chloride. The properties of the gasoline are given in Table 1.

[1]Translated from the Russian oil journal *Vostochnaya Neft*, No. 9, 1940, by A. A. Boehtlingk, Berkeley, California.

Procedure

To the gasoline in a 1-liter cylinder, a corresponding amount of commercial aluminum chloride was added and the mixture agitated until there was no further formation of new compounds. The beaker then was set aside to allow the precipitate to settle.

An almost complete conversion of the aluminum chloride and sulphur compounds occurred when treating the gasoline with 3 percent aluminum chloride. When the treatment consisted of adding 6 percent, however, and particularly when adding 9 percent aluminum chloride to the gasoline, the conversion was not complete despite four to six hours of continuous agitation. All samples of the complexes were stored as gasoline. The complexes were very fluid, particularly when formed by using 9 percent aluminum chloride, and their Engler viscosity probably did not exceed 3 to 4 at 50°C. Their viscosities, however, could not be determined because the complexes became coated with semi-solid crusts when exposed to the air. Each of the samples of the complexes was decomposed individually with water for the separation of the organic substances. These organic substances were carefully washed with water and the small amount of emulsion formed was decomposed separately with hydrochloric acid. The organic products obtained in the breaking up of the emulsion were washed with water and then added to the main portion of the organic products. Organic substance obtained by the addition of 3 percent aluminum chloride to the gasolines had a slightly darker color than those obtained when 6 percent aluminum chloride was used. Upon standing, these organic substances darkened relatively rapidly and after only 24 hours their color was a dark brown. Data giving conditions under which the complexes were formed, their yields, and the percentage of sulphur in the refined gasolines are presented in Table 2.

The following determinations were made on the organic substances separated from the complex—content of sulphur by the lamp method, content of chlorine, specific gravity by means of a picnometer, and an Engler distillation. Distillations were carried out until white vapors appeared in the flask, which was an indication that the residue was beginning to decompose. Other tests that were made included determinations of the sulphur and chlorine contents and the specific gravities of the redistilled distillate, which had a brighter color than the original gasoline. The residue left after the distillation had been completed was a black viscous product with a dark red shade and a specific gravity greater than 1. The results of the analysis are given in Table 1.

In order to determine the group com-

TABLE I

Organic substance obtained for following consumption of aluminum chloride in percent	Original organic substance												Distillate		
				Engler distillation, °C.											
	Specific gravity	Sulphur, percent	Chlorine, percent	I.B.P.	100	120	140	160	180	200	End-point	Residue, losses	Specific gravity	Sulphur, percent	Chlorine, percent
3	0.890	8.33	0.325	80	2.5	8	16.7	47.3	66.8	82	225	14.7	0.872	10.67	0.513
6	0.886	10.15	0.673	80	6.3	12	21.8	35.5	55.8	77.5	212	12.5	0.866	9.98	0.51
9	0.880	5.82	0.433	79	6.3	11.3	22.5	34.7	53.0	87	214	7.5	0.862	7.78	0.484
Original gasoline	0.719	0.35	.....	38	34.5	51	65.5	79.5	....	....	199	3.0	.....	.....	.....

TABLE 2

Consumption of aluminum chloride in percent by weight	Yield in percent gasoline by volume		Percent sulphur in refined gasoline
	Complex*	Organic substance	
3	1.44	0.51	0.04
6	2.44	0.88	traces
9	4.78	1.00	0.00

*Considerable losses occurred as the result of sticking to the sides of the container.

position of the sulphur compounds, a mixture was prepared of the distillates that had distilled off the organic substances obtained from the complex. The mercaptan, disulphide, sulphide, and residual sulphur contents were determined by the Farragher, Morrell, and Monroe method. The mercaptans were separated by using an alcoholic doctor solution, and the disulphides were reduced with hydrogen to mercaptans, followed by their removal. The sulphides were removed with mercury nitrate, and the residual sulphur was determined by difference. In all cases an excess of reagent was used in the determination of the group composition of the sulphur as required by the method. The obtained data (Table 3) show that most of the sulphur compounds are sulphides.

The individual portions of undistilled sulphur compounds were then treated with commercial sulphuric acid, and energetically agitated in a glass cylinder. In one experiment, 40 cc. of sulphuric acid was mixed with 10 cc. of the sulphurous substances. In the second experiment, 21 cc. of sulphur compounds were treated with 21 cc. of sulphuric acid. A separation of small amounts of a sulphur dioxide was observed upon shaking the mixture and then letting it stand. As a result, 70 and 66.7 percent, respectively, of sulphur compounds were absorbed. The amount of sulphur in the substances that was not absorbed by the sulphuric acid amounted to 10.2 percent.

One of the other practical properties characteristic of the sulphur-containing distillates is their ability to dissolve rubber. In the experiments the type of rubber used was that used to make rubber cement. A sample of rubber weighing 0.16 grams was very rapidly dissolved in 3 cc. of the sulphur-containing distillate, forming a thick, viscous, homogeneous mass.

When a thin film of the residue left after the distillation of the sulphur-containing substances was placed on a sheet of glass or on an iron slab it dried at a slow rate forming an even solid film. This film, however, could be dissolved readily by moistening it with gasoline.

TABLE 3

Sulphur compounds	Content in sulphur compounds in percent	
	In the organic part	In the organic sulphur-containing part of the complex
Distillate under investigation	8.92	100
Mercaptans	0.37	4.14
Disulphides	1.34	15.01
Sulphides	6.36	71.30
Residual sulphur	0.85	9.55

Conclusions

(1) Organic substances separated from the complex are of interest from an industrial point of view. They are a mixture of sulphur compounds, mainly sulphides.

(2) The sulphur-containing distillates may be used as a raw material in the chemical industry for the preparation of mercaptans or sulphides.

(3) There is a possibility of using sulphur-containing distillates in the rubber industry.

(4) The residue left after the distillation of the sulphur-containing substances may be used as a film-forming substance.

☆ ☆ ☆

P 730.

Bubble Trays Fabricated by Arc Welding

ONE of the many unusual applications of electric arc welding recently noted in the industrial field was contained in a report from the Big Three Welding Company, Inc., Fort Worth, Texas, describing the construction methods used in building intricate bubble trays for manufacturing high-octane gasoline at a Southwestern refinery.

Details of the arc-welding procedures specified by the designers, Fritz W. Glitsch and Sons, were brought out in a letter recently received by The Lincoln Electric Company, Cleveland, Ohio, manufacturers of arc-welding equipment.

The job consisted of fabricating 200 large bubble trays used in producing war essential gasoline for the nation's fighting equipment.

Each tray, measuring 12½ ft. in diameter and weighing 1800 lb., has a total of approximately 400 bubble caps —small block-shaped pieces arranged closely together in rows to the top of the tray—composed of 5 sections of 16-gauge stainless steel and measuring 4 in. by 4 in. by 3 in.

The bubble caps are constructed by tack welding the steel sections to the base plate, using a special welding rod designed for stainless steel, applying one tack weld to the corner of each bubble cap and laying a continuous bead along the seams as shown in the accompanying photograph.

A bubble tray made by arc welding

These all-welded bubble caps, which were formerly made of cast iron, have been in use for 5 years without replacement. The savings effected by the use of arc-welded design is evidenced by comparing this type of construction with the former casting method. After five years' use, the welded equipment shows no noticeable signs of wear, whereas the former cast-iron caps had to be replaced after about 10 months' service. ☆ ☆ ☆

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Among the modern base chemicals being produced from natural and petroleum refinery gases, Badger engineering and construction cover such products as:

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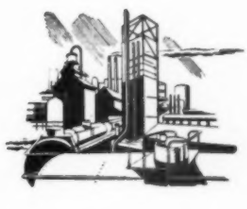
Badger builds plants for the Chemical Industry



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Slide Rule Decimals

☆ Simple and practicable method of determining position of decimal point in slide rule calculations

PETROLEUM ENGINEER Exclusive Feature

by Paul F. Marx

Technical Engineer, U. S. Maritime Commission

MATHEMATICIANS find slide rules invaluable in speeding-up computations, but are often retarded by the placing of the decimal point.

The following method has proved indispensable and its convenience increases with use. Simple rules and explanatory examples are given to convey the method of determining the position of the decimal point in the answer.

If the engineer or mathematician uses the fundamental rules, follows the examples, and then sets up a few practice problems of his own, he will find this method simple and practicable.

The slide is the only part of the slide rule involved. The only time it need be considered is when it extends to the right of the rule.

When multiplying with a slide rule, the values used in determining the location of the decimal point should always appear in the numerator. In dividing with a slide rule, the values used in determining the location of the decimal point should always appear in the denominator.

Fundamentals of Method

Fundamentals of the method are as follows: (1) In multiplication, each time the slide extends to the right of the slide rule place a minus one (— 1) in the numerator. (2) In division, each time the slide extends to the right of the slide rule place a minus one (— 1) in the denominator.

For multiplication	— 1
For division	— 1

Reviewing the significant figures in the digit system we find all the digits to the left of a decimal point are significant, that is, 223.0 has three significant figures; in the units place, tens place, and hundreds place; and is given a value of + 3. The figure 5.016 has one significant figure in the units place and is given a value of + 1. Six significant figures are contained in 602000.132 and therefore it has a value of + 6.

Decimal Fractions

When dealing with decimal fractions, only the ciphers immediately to the right of the decimal point are considered, that is, 0.0116 has one cipher and would be given a value of — 1, whereas 0.00008 has a value of — 4, and 0.0006003 a value of — 3.

The algebraic summation of these values gives the value to be used in placing the decimal point in its proper position in the answer.

Multiplication

Below is a simple example of multiplication (using the "C" and "D" scales of the slide rule. See Fig. 1):

$2.2 \times 300 = 66.$

As the slide extends to the right, a — 1 is written down in the numerator,

— 1

Then the values of the significant figures are added in; 2.2 has a value of 1,

+ 1 — 1

and 300 has a value of + 3,

+ 1 + 3 — 1

The algebraic sum equals + 3, therefore, in the answer there are three significant figures to the left of the decimal point, and it is placed as shown, 660.

It is well to remember that after the algebraic summation a plus sign indicates there are digits to the left of the decimal point, whereas a negative sign shows the digits will all appear to the right of the decimal point.

If the foregoing example had been

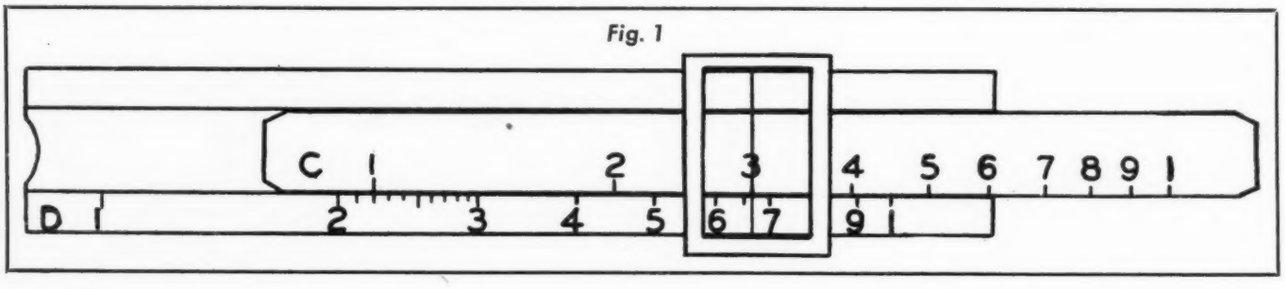

Fig. 1

PAUL F. MARX

received his education at the Western Military Academy, Alton, Illinois, and the Colorado School of Mines—Since 1921 he has followed experimental and engineering lines and has been affiliated with the following companies: American Metals Company, Ltd., experimental flotation; Standard Oil Company of Indiana, combustion engineer; White Eagle Oil and Refining Company, development department; Skelly Oil Company, propane and butane experimental work; engineer for eight years with the Natural Gas Pipeline Company of America; engineer with Northern Natural Gas Company, and is now doing technical engineering for the United States Maritime Commission.

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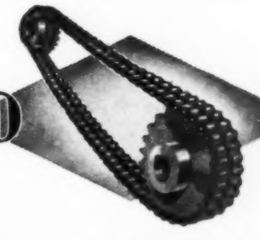
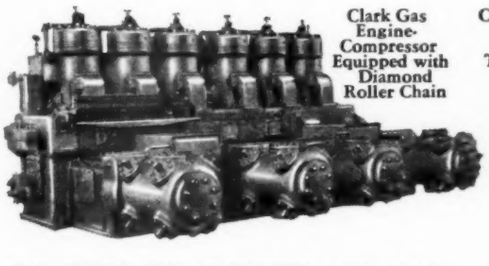
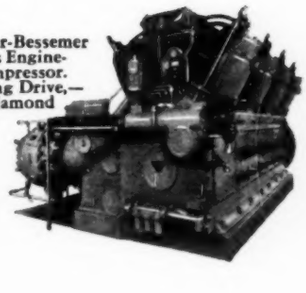
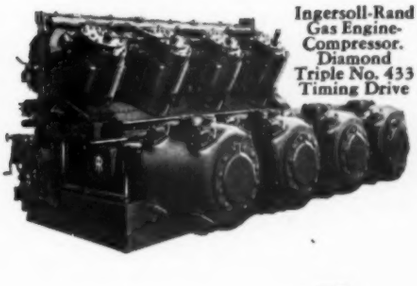
DIAMOND  **ROLLER CHAINS**



Clark Gas Engine-Compressor Equipped with Diamond Roller Chain



Cooper-Bessemer Gas Engine-Compressor. Timing Drive,—Diamond



Ingersoll-Rand Gas Engine-Compressor. Diamond Triple No. 433 Timing Drive

$0.00022 \times 300 = 66$ the slide still extends to the right giving a -1,

$$-1$$

and 0.00022 has a value of -3,

$$-3 \quad -1$$

while the value of 300 remains $+3$,

$$-3 \quad +3 \quad -1$$

and the algebraic sum is -1,

$$-3 \quad +3 \quad -1 = -1$$

consequently, there is one cipher to the right of the decimal point and the answer becomes, 0.066.

Another example of multiplication is $0.00152 \times 6000000 \times 0.74 = 675$. During these three multiplications, the slide extends to the right only once, or

$$-1$$

Then 0.00152 has a value of -2,

$$-2 \quad -1$$

and 6000000 has a value of $+7$,

$$-2 \quad +7 \quad -1$$

adding these algebraically,

$$-2 \quad +7 \quad -1 = +4$$

so the answer has four places to the left of the decimal and becomes, 6750.

A more complicated example is as follows:

$$\begin{matrix} (-7) & (+5) & (-4) \\ 0.0000000242 & \times\ 81000 & \times\ 0.000026 \\ (+2) & (-4) & (0) \\ \times\ 12 & \times\ 0.00005 & \times\ 0.45 \end{matrix}$$

It is well to draw the division line before working the problem and to jot down a -1 each time the slide extends to the right. Working the problem from left to right the steps of the values are shown,

$$-1$$

$$-1 \quad -1$$

Answer digits = 138

Then the values indicated above are filled in,

$$-7 + 5 - 4 + 2 - 4 + 0 - 1 - 1$$

$$= -17 + 7 = -10$$

so the answer is, 0.0000000000138.

It is necessary to draw only one division line and fill in the values while proceeding with the problem.

Dividing

In division, the procedure is similar to that in multiplication, except the values will appear below the division line, when the slide extends to the right, instead of above as in multiplication.

A simple example follows:

$$\frac{600}{12} = 5$$

As the slide extends to the right a minus one (-1) appears below the division line,

$$-1$$

600 in the numerator has a value of $+3$

$$+3$$

$$-1$$

and 12 in the denominator has a value of $+2$,

$$+3$$

$$+2 \quad -1$$

adding algebraically:

$$\frac{+3}{+2 \quad -1} = \frac{+3}{+1}$$

A fundamental fact that must now be set forth is that the values in the denominator are always *subtracted* from the values in the numerator, therefore,

$+3 - (+1) = +3 - 1 = +2$

So there are two digits in the answer to the left of the decimal point, and the answer is 50.

Another problem in division is given to clarify the procedure,

$$\begin{matrix} & & & & & (-4) \\ & & & & & 0.0000190 \\ \hline 38000000 & \times\ 0.00000004 & \times\ 150 & \times\ 11000 & \times\ 0.0376 \\ (+8) & (-7) & (+3) & (+5) & (-1) \end{matrix}$$

The slide during the operations of division is extended to the right three times, and as a minus one (-1) is placed below the division line each time they appear as shown below,

$$-1 \quad -1 \quad -1$$

and the values of the digits, as indicated above, then appear as shown,

$$-4$$

$$+8 - 7 + 3 + 5 - 1 - 1 - 1 - 1$$

It is not necessary to write the values of the digits in parenthesis as above. In application these may be marked down above and below the division line as they are mentally determined.

Adding algebraically and subtracting the denominator from the numerator,

$$-4$$

$$+8 \ -7 \ +3 \ +5 \ -1 \ -1 \ -1 \ -1$$

$$= \frac{-4}{+16 \quad -11} = \frac{-4}{+5}$$

$$= -4 - (+5) = -9$$

Multiplying, Dividing Combined

The last example given shows a combination of multiplication and division. Any sequence of multiplication or division can be followed. The multiplication may be made first or the division first, or a combination of the two. The final number of times that the slide extends to the right will remain the same.

$$\frac{5000 \times 24 \times 15 + 0.48}{75000 \times 0.00011 \times 0.012 \times 0.02} = 436$$

$$+8 \ -1 \ -1$$

$$+5 \ -5 \ -1 \ -1 \ -1$$

$$= \frac{+6}{+5 \ -8} = \frac{+6}{-3}$$

$$= +6 - (-3) = +6 + 3 = +9$$

The answer is 436000000.

As stated previously, this method of locating the decimal point in slide rule calculations will become very simple with a little use or practice.

☆ ☆ ☆

Blame Diesel Engine Wear and Fouling on Inadequate Fuel

Blame for wear and fouling of Diesel engines was shifted from lubricants to unsatisfactory fuels at the Diesel Engine and Fuels and Lubricants Meeting of the Society of Automotive Engineers in Cleveland, Ohio, recently.

Shift of culpability from the traditional to the actual villain was accomplished by G. H. Cloud and A. J. Blackwood, of Standard Oil Development Company, Elizabeth, New Jersey, who reported the results of pioneering research of the effects of fuel characteristics upon engine wear and fouling.

Asserting that selection of suitable fuels is an important control factor, they said the major Diesel fuel characteristics governing fouling and wear are sulphur content, ignition quality, and viscosity and/or volatility. Sulphur content was held the most important. Sulphur converts during combustion into sulphur trioxide, which attacks lubricating oil, produces sludge, varnish and carbon formation, increases ring and cylinder wear.

Fuels of lower cetane number were found to reduce ignition quality, increase smoke and roughness, but apparently exert no discernible influence on wear. On the other hand, little improvement in engine conditions results from using fuel of a cecane number higher than that necessary for smooth operation.

Fuel viscosity and volatility of normal fuels are closely related, appreciably effect fouling and wear in certain types of equipment. Limitations on these characteristics to control smoking were said to control fouling and wear also.

Life-Saver for Men and Materials

A SIGNIFICANT development to come out of the first World War was a black, granular substance known as activated carbon.

Particles of this material are so highly porous and have such tremendous active surface area, that they can pick up and hold surprising amounts of toxic gases, volatile vapors, and odors. Developed by NATIONAL CARBON COMPANY, INC., a Unit of UCC, to meet the specific menace of gas warfare, activated carbon saved many lives during the last war as an important ingredient in gas mask canisters.

After the Armistice, this amazing material was further developed by CARBIDE AND CARBON CHEMICALS CORPORATION, another Unit of UCC, for numerous industrial uses. As a result of this work, one type of activated carbon is now saving millions of gallons of such essential solvents as alcohol, ethyl acetate, ether, and acetone, previously lost through evaporation in manufacturing processes. This is accomplished by passing vapor-laden air from solvent-using processes through tanks containing COLUMBIA activated carbon, and then steaming the solvents out of the carbon.

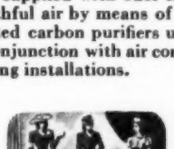
This year, in smokeless powder plants, plants making plastics, and in other plants engaged in war work, it is estimated that savings will amount to over 100 million gallons of solvents.

And the work of activated carbon is just beginning. Through the constant research that typifies all UCC Units, CARBIDE AND CARBON CHEMICALS CORPORATION has developed still newer uses which are contributing to the nation's health and welfare.

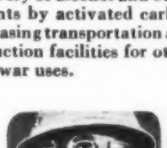
BUY UNITED STATES WAR BONDS AND STAMPS

FRESH AIR! War workers are kept supplied with odor-free, healthful air by means of activated carbon purifiers used in conjunction with air conditioning installations.

SAVINGS FOR INDUSTRY! Recovery of alcohol and other solvents by activated carbon is releasing transportation and production facilities for other vital war uses.



SAVINGS FOR YOU! In making plastics, artificial leather, one type of rayon, and many other products, the recovery of solvents with activated carbon results in savings to consumers.



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Corrosive Effect of Alternating Currents on Pipe Lines

PETROLEUM ENGINEER Exclusive Feature

☆ Metal loss from this source now considered greater than was formerly believed

by Starr Thayer

Consulting Engineer

THIS writer, together with many others, has often made the statement that the loss of metals due to alternating currents was unimportant. It has been said that such losses were less than 1 percent of the losses due to the same amount of direct current. Nevertheless, corrosion losses have been noted lately that indicate that these currents are not so guiltless. Losses have occurred that could not be accounted for in any manner except as caused by these currents. Such losses have caused the writer and others to investigate this problem.

First let it be said that it is easily possible for pipe lines to accumulate the alternating currents. This could occur in electric-driven booster stations, especially when the grounded neutral system is used. Hundreds of miles of rural electric lines have been erected in which the earth is used for one conductor. Pipe lines in the general vicinity of one of these lines would be expected to gather some of these currents. A pipe line paralleling a high voltage transmission line could pick up some current through induction. Instances have been found where such has occurred even when the lines were several hundred feet apart.

For the benefit of the pipe-line operator, who possibly has not studied much electrical engineering, a little explanation of the currents would not be out of place. It is known that when direct current passes from a metal and into the soil it carries a certain amount of the metal with it. Now alternating current changes its direction 120 times per second. In other words, half of the time the current is flowing in one direction and reverses during the other half of the time. For this reason it has been assumed that these currents would be harmless, the theory being that the damage that might be caused by the currents leaving the pipe would be offset by the currents returning to it. This possibly could be the condition if the same amount of current returned to the pipe that left it.

STARR THAYER

prior to becoming a consulting engineer in 1938, served the United Gas Public Service Company as corrosion engineer for seven years —He received a bachelor's degree in electrical engineering from Iowa State College, was a captain in the engineering corps during the World War, and for many years was an electrical contractor, constructing power plants, electrical railroads, etc.—Thayer was one of the pioneers in the field of protecting pipe lines cathodically, and is regarded as an authority on that subject as well as on corrosion problems in general—Makes his headquarters in Houston, Texas.

Almost all pipe-line operators have had some experience with or at least have seen the rectifiers that are used in applying cathodic protection to pipe lines. This unit rectifies the alternating current from the power line into direct current. This is possible only for the reason that the copper oxide, which is the main element in the rectifier, permits current to flow in only one direction. Now there are other elements that also permit current to flow in one direction. The early rectifiers used aluminum oxide for this purpose. Iron oxide has this property to a more or less degree. If a pipe line was in a location where it was carrying some of these alternating currents and if the pipe was rusty at some places, we would then have a rectifier at the areas where the current was being collected and also at the points where it was being discharged. In other words, we will have direct current leaving the pipe at both of these areas with the resulting loss of metal.

To prove that this is not a theory the following test was made. A rusty steel plate was set up in a solution of salt water. A carbon plate was set in the same solution but some distance from the plate. A bright steel rod was set between these plates. A reading was taken between the rusty plate and the rod with a high resistance voltmeter. The plate was 0.04 volts positive to the rod. The plate and the carbon plate were then connected to the terminals of a low-voltage transformer. Alternating current then passed between the two plates. The steel plate was now in the same state that a pipe line would be in the areas referred to above. The voltage between the steel plate and the rod was now 0.13 volts. This shows that the plate had now become 0.09 volts positive to the water.

All this does show that alternating currents can cause damage. At least two instances in practice have also borne this out. In these cases trouble was being experienced with heat exchangers where none should have been expected. In both cases all piping leading to the exchangers was insulated so that currents could not pass into or out of the exchangers. When this was done tube failures practically ceased.

It is not probable that these currents have caused any great damage to pipe lines except possibly in a few isolated cases. It is probable, however, that they have caused considerable damage such as described with the heat exchangers.

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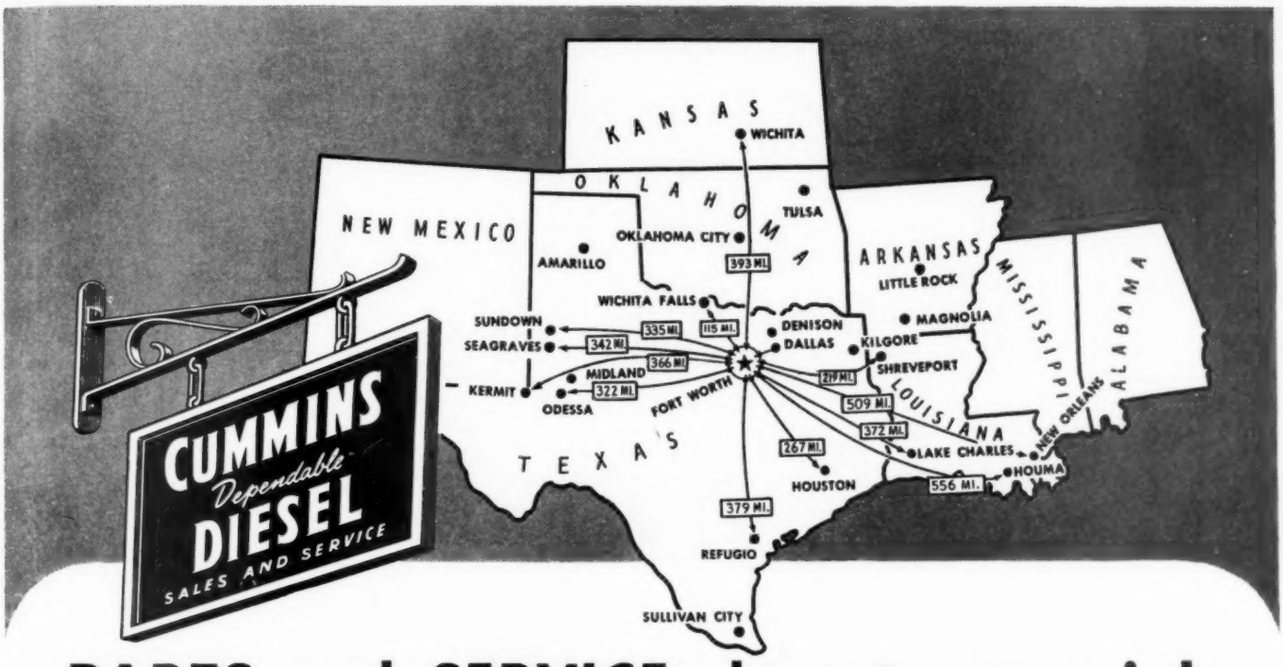

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Refinery Practice for the Operating Man

Vocational Class Proceedings in Refinery Engineering

Manufacture of Lubricating Oils

Class Meeting No. 10 (Continued)

NOTE: Throughout the class proceedings, no attempt is made to distinguish the identity of the pupil speaking. When a series of remarks is made by pupils it usually denotes an interchange of discussion among the class members themselves.

Pupil: What would be a good definition of lubrication?

Pupil: (reads) Here we have a good definition of lubrication:

"A substance used to reduce friction or make surfaces slippery. The lubricant tends to eliminate the effects of asperites of the surfaces, to prevent abrasion between the surfaces and to introduce a material, either solid or fluid, of sufficient consistency to maintain a film which can be easily sheared. The opposite of abrasive."

There are two theories of film breakdown and that is what we are fighting against, and those two theories are that the asperites or raised portions come in contact with each other when the film breaks down, causing hot spots in metals rubbing together and causing welding or fusion, and then the other is that when these two metals come together they come in contact and the actual pulling apart of the molecules generates enough heat to weld the metals together. One theory of chemical nature and one mechanical of film break-down is bearings. The main thing is to maintain actual fluid separation of the metal under discussion and if you have two metal surfaces separated by oil, it is required of the oil between these metals to build up an internal pressure inside the oil equivalent to the load. These oils must be viscous enough to resist the pressure of the load.

Pupil: The viscosity is the most important part in fluid lubrication.

Pupil: Is it the slope of the viscosity index curve?

Pupil: The viscosity. Most authorities I find say that viscosity is the most important part of lubrication, that is, so long as you maintain a fluid film between the bearings.

Pupil: The fluid friction is directly proportional to the viscosity.

Pupil: And is the film strength directly proportional to the viscosity?

Pupil: I don't think so. I don't think you will find any relationship.

Pupil: Why would the higher viscosity be required for carrying higher load?

Pupil: That is in maintaining actual fluid friction. In boundary friction you have something else.

Pupil: You say that oiliness only applies to boundary lubrication?

Pupil: Yes.

Pupil: I don't believe it does. It is connected with boundary lubrication, but you have friction whether it is gas, liquid, or solid.

Pupil: What is oiliness?

Pupil: Its chief function is reduction of friction, and you have molecular layers in the viscous film, and you can have friction between the layers of oil the same as between the layers of metal and oil.

Pupil: I don't believe the definition says that. Will you read it? There is a definition of oiliness.

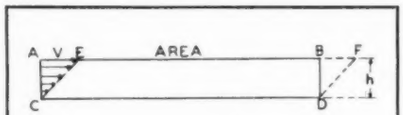

Fig. 19

Pupil: It gives a definition of oiliness and unctiousness.

Pupil: It says it is a substitution for liquid.

Pupil: (Reads definition of oiliness) Oiliness is defined as the property that causes a difference in friction when two lubricants of the same viscosity at the same temperature of the film are used under identical conditions.

In other words, the lubricating value of adsorbed film is oiliness.

Leader: When the differences in friction are greater than the viscosities will account for, that is termed oiliness.

Pupil: In your statement, were you taking into consideration any temperature rise?

Pupil: When we speak of viscosity, in preliminary discussion, I believe we will have to stick to the viscosity of the oil at the temperature we happen to be discussing; if we say viscosity of the oil between piston and piston walls, it might be about 250°F.; if we speak of the viscosity of that oil as a lubricant, we will have to consider the temperature; if we say that oil of a certain viscosity will exert a certain pressure against a bearing surface, then we will have to consider that if the temperature is raised, the viscosity will change.

Pupil: I was just trying to combine that statement with the statement that had to do with viscosity.

Pupil: I said the viscosity was the most important factor of fluid friction so long as you maintain a fluid friction between the metal surfaces. The viscosity of the oil is the only thing that holds those surfaces apart and when the film becomes very thin oiliness prevents metal to metal contact. In "Lubrication" by Clover, it says:

"When conditions of thick film friction occur, therefore, the frictional resistance is no longer affected by the chemical constitution of the lubricant or the nature of the solid surfaces, as in thin film friction, but is influenced only by the internal friction of the lubricant itself, which friction is proportional to the viscosity of the lubricant."

Pupil: What about the effect of additive agents not in boundary friction but in the development of slippage planes of lubrication in fluid friction?

Pupil: That would take into account, I believe, the viscosity of the oil. The viscosity of the oil is actually the shearing stress. S equals the shearing stress and R the resistance to shear. SS is directly proportional to the rate of shear and if you decrease the resistance to the rate of shear, then the absolute viscosity, which is K, will be decreased.

In Fig. 19, the two planes AB and CD are separated by a film of oil. Now we slip this top plane. We call V, from A to E, a constant velocity. The area of this surface is A. R is equal to velocity over the distance those planes are apart. That is my definition.

Leader: Is V really a distance?

Pupil: That is the rate of shear. You are moving the fluid films and they are connected between two plates, which

...like Straws in the Wind

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we consider closed, and then the bottom molecules will actually stick to the bottom plate and the top ones to the top plate.

Leader: What happens to the other layers of oil?

Pupil: They form horizontal lines in the triangle.

Leader: They are gradient?

Pupil: Yes. S equals force divided by the area. That is merely the definition of the rate of shear. The S or shearing force per unit area equals the total force divided by the area and as S equals R, that is equal to the constant or Z, which is absolute viscosity. This is all an action governed by a constant, which is defined as Z times V over H or the force is equal to Z times the area times the velocity over the thickness of the film.

Pupil: Frictional force?

Pupil: Yes. The frictional force in the fluid friction is directly proportional to the viscosity of the fluid and to the size of the area, and directly proportional to the rate of shear.

Leader: If Z is the viscosity, then the lowest viscosity you can have and still have proper lubrication will require the least force?

Pupil: Yes.

Pupil: That viscosity would actually change and be a different figure if the pressure on AB were increased. Is that right?

Pupil: That will not make any difference. We can solve the equation, and the viscosity is equal to the force divided by the area times the thickness over the velocity. If you have all these things, you can determine the viscosity of your oil and the pressure does not make any difference.

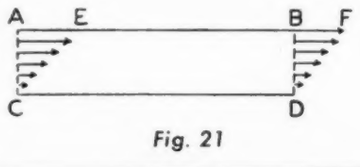


Fig. 21

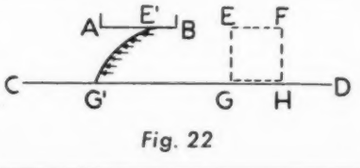


Fig. 22

Pupil: In order to keep R the same, you would have to increase the Z, wouldn't you?

Pupil: Yes.

Pupil: What is the elastic constant of the metal?

Pupil: I don't know.

Pupil: So long as you have fluid friction, the metal makes no difference.

Pupil: Are you going to stay with that all the time?

Pupil: Yes.

Pupil: You mean it would not make any difference if you have prongs sticking down there?

Pupil: Both our theory and practice indicate that the expression absolute viscosity times the speed divided by the pressure plotted against friction is a very significant thing (see Fig. 20). Absolute viscosity is Z, the N equals r.p.m. of the journal bearing, and P is in lb. per sq. in., and when this friction gets in this area, you get into boundary friction and at this transition point the coefficient of friction is the least. Then as you increase either, you can increase the speed of the bearing or viscosity of the oil, or decrease the pressure, and the coefficient of friction will go up. A similar line to that can be drawn to any bearing that you operate.

Pupil: Independent of the pressure?

Pupil: So long as the distance separating the two remains the same. In operation the pressure is going to close the distance between the metal surfaces and as pressure is increased the cofficient of friction becomes smaller at this point. Is that clear? I could explain it further, but that is from a recent publication of actual bearing experience.

Pupil: From the viewpoint of practice, you would want to get somewhere close to the low point?

Pupil: Yes.

Leader: However, you can't get some people to agree just where it stops.

Pupil: No, not very many people even claim to know.

Pupil: This is for two perfectly stationary surfaces, there is no movement?

Pupil: Yes; if the velocity becomes zero, then the cofficient of friction increases, and if you stop—in other words, in starting and stopping a motor, you have boundary friction. When N is zero, friction increases greatly. Take two planes AB + CD in Fig. 21. These are infinite in length and you move the top one from AB to EF, then theoretically the closest adjacent molecules of oil will cling to the surface. Then the lines of velocity as in triangles AEC and BFD is the velocity as compared to the velocity of the top plate through that area.

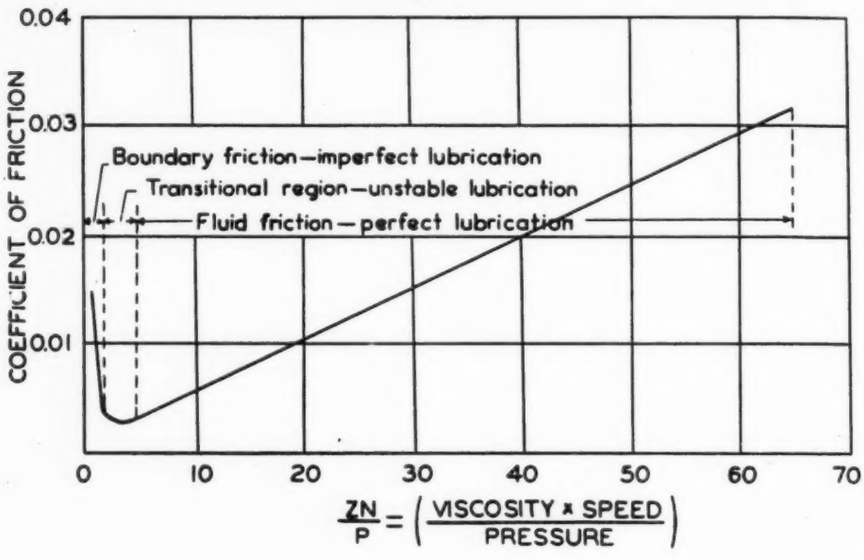
Pupil: Are you still talking about boundary lubrication?

Pupil: No, this is fluid lubrication. We rub the top line out and find that if, as in Fig. 22, metal surface AB is short and CD remains infinite and oil is forced between the plates then the velocity is on the bottom as this plate moves and forces oil through. The oil velocity will be high on the bottom and gradually come down to a minimum. Take the square EFGH of that oil as it goes between the plates. Say there is a slug oil going through there with some pressure between the two layers. Then the oil inside will tend to come into a circle as G'E'. The actual amount of oil being forced through this area G'E' will cause the forces to push against this plate and that force is directly proportional to the viscosity of the oil. Resistance to shear in the oil forces these plates apart.

(EDITOR'S NOTE: This series will be continued in an early issue of *The Petroleum Engineer*.

☆ ☆ ☆

Fig. 20



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A New Conception of Acidizing

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PART 3 (Concluded)

by C. E. Clason

Superintendent Acidizing, Halliburton Oil Well Cementing Company

TABLE 1 shows the increases to be expected from acidizing and indicates the calculations involved. If results obtained per stage are considerably above the indicated computations for a given well, crevice conditions are present. Lower increases indicate that with a large initial test the well pay formation already has a maximum permeability, or that with a small initial test the formation lacks effective porosity or contains very little gas.

If the crevices in the formation are long, much greater increases will be obtained. Large wells initially may have a pay formation of character, shown by accompanying tables in respect to percent increase by acidizing.

If mud has penetrated the formation to any great extent, larger increases than shown in the table may be obtained after the 1000 gal. and possibly the 4000 gal. treatments have been made. In other words, it is possible that the normal permeability can be obscured for a greater distance from the bore of the well. Checking the gas flow will determine this and indicate what subsequent stages of treatment are possible.

An illustration of penetration and theoretical gain in production from an acidized oil well is given here; gas wells may be calculated in the same way by substituting cu. ft. for bbl. of oil:

Well production—100 bbl. initial production.

Producing formation—limestone or dolomite.

Pay thickness 3 ft., 15 ft., and 10 ft.—total of 28 ft.

Acid shot, 5000 gal., porosity, 15 percent.

Using Fig. 1, penetration in 100-ft. thickness of pay for 5000 gal. at 15 percent porosity equals 44 in. (midway between 10-percent and 20-percent curves).

Using Fig. 2, factor, 1.9. 44 in. $\times$ 1.9 $=$ 84 in., or the penetration for 5000 gal. in 28 ft. of pay with 15 percent porosity and uniform permeability. (Acid travels 1.9 as far in 28 ft. of pay as it does in 100 ft.)

The theoretical increase in production, if the well is clean and permeability is not obscured but increased ten times, is as follows:

84 ft. $=$ 7 ft. Fig. 4 shows 67 percent to be expected, or to 167 bbl. A greater increase means a mudded condition or crevices.

Same well: Using 5000 gal. in stages: First stage—1000 gal.; Fig. 1, penetration of 18 in. $\times$ 1.9 $=$ 34.2 in. or 3 ft. From Fig. 4, 42 percent increase to be expected, or 42 bbl. more to 142 bbl.

Second stage—4000 gal.; Fig. 1, 39 in. $\times$ 1.9 $=$ 74.1 in. or 6 ft. From Fig. 4, 6 ft. shows 62 percent, or 62 — 42 $=$ 20 percent gain. 142 $\times$ 1.20 $=$ 170 bbl. to be expected.

If the well produces as calculated after the second stage, another stage of treatment would not appear to be justified. The most returns have been received from the first 1000 gal. Nothing has been gained in production by two-staging, but the channels near the well bore are larger and should not plug up so soon.

Same well:

First stage—1000 gal.; assume production was increased to 300 bbl., or 200 percent. Probably the pay either was mudded-off or crevice conditions existed.

Second stage—4000 gal.; from Fig. 4 in the previous example, the production would be expected to increase to 360 bbl., or 20 percent. If production did increase this amount or less, more acid would not be of much benefit. Assume production was increased to 500 bbl., or 166 percent, it would appear that crevice conditions existed and more acid should benefit.

Stage treatments of 500 gal., 2000 gal., and 8000 gal., or 250, 1000, and 4000 gal., can be computed in the same manner. This may be desirable on small wells or in the case of thinner pays.

Predictions can be made after a second stage by calculating a third-stage treatment and its expectancy based upon results from the second stage. As Fig. 4 is expressed in percentage, the size of an oil or gas well will often be the determining factor in comparing costs of acidizing with the results to be obtained. For instance, a 20 percent expected increase on 50 bbl. would be an additional 10 bbl. and would perhaps not warrant a third larger stage, when the same percent increase on 500 bbl. would be entirely feasible. The same principle applies to gas wells.

This procedure, with the operator's coöperation in making production tests, will show the volume of acid to use to obtain the most production per unit acidizing cost. It can prove the past use of too much or not enough acid.

TABLE 1

Example of percent increase in production of gas wells to be expected after normal permeability is established at well bore, with uniform permeability and porosity of formation.

Estimated for an average porosity of 15 percent or midway between 10 and 20 percent; taking the production as 6 percent above normal after first washing with weak acid. Taken from Fig. 4.

Gal.	100 ft. pay, percent	Increase per stage, percent	50 ft. pay, percent	Increase per stage, percent	25 ft. pay, percent	Increase per stage, percent
1,000	28	22.0	36.5	30.5	45	39.0
4,000	45	17.0	54.5	18.0	64.5	19.5
8,000	54	9.0	65.25	10.75	76.5	12.0
12,000	61	7.0	72.5	7.25	84	7.5

Variation in porosity causes very small differences in figures given in Table 1. Thickness of pay is an important factor. Estimates of expected increase close enough for practical needs may be made by choosing the figures in the columns of pay thickness that are nearest to the thickness of pay to be acidized.

Example: (Using figures in above table) based upon a ten-fold increase in permeability:

All flow test readings made after washes	100 ft.	50 ft.	25 ft.
Reading, gal. of acid	3,000,000	3,000,000	3,000,000
1,000	3,660,000	3,915,000	4,170,000
4,000	4,280,000	4,620,000	4,985,000
8,000	4,665,000	5,016,000	5,540,000
12,000	4,990,000	5,441,000	6,000,000

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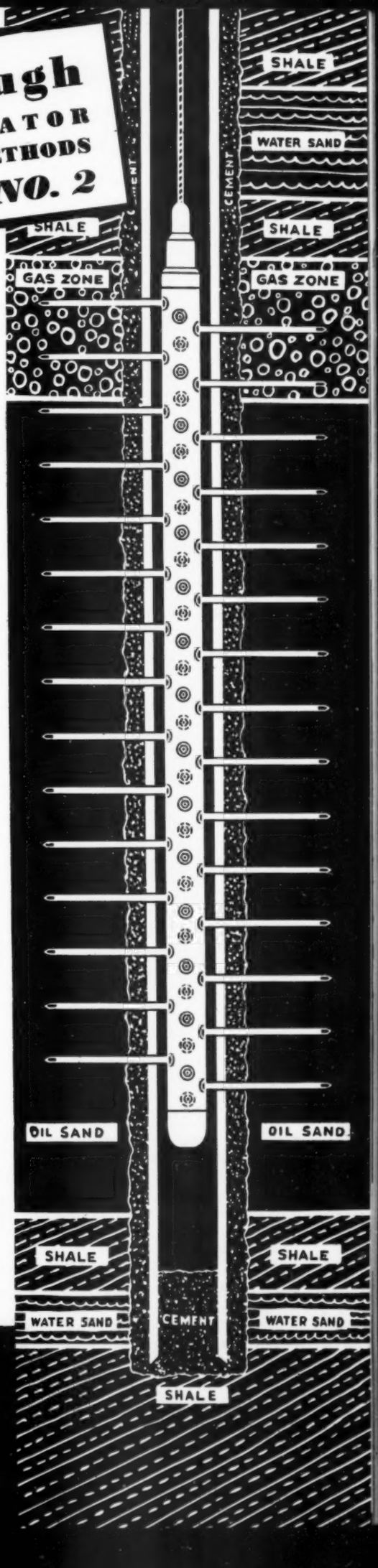

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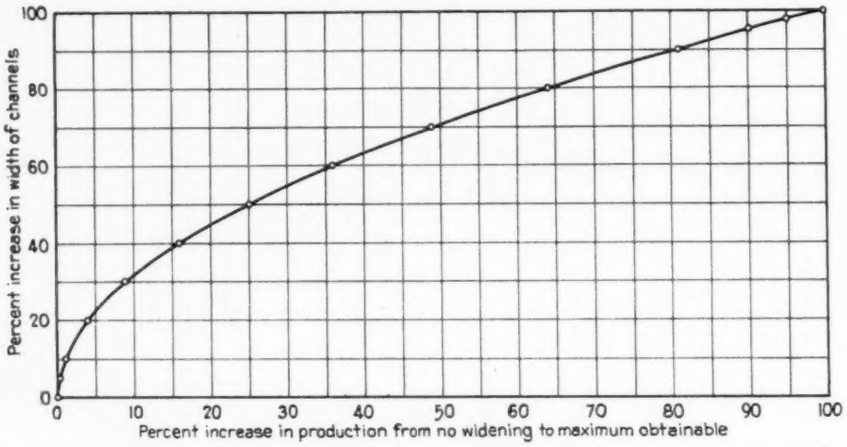

Fig. 6. Percent increase in production by channel widening, which is obtained by proper time for acid contact

Acidizing With Fluid Loads

Table 2 shows the effect of water or oil injection behind acid, time of pumping, and their relationship to production increase from channel sizes and radius of travel. It is based upon known conditions of rate of reaction under pressure between acid and the two types of producing formations. (Fig. 5.)

In determining channel sizes, curves in Fig. 5 were used. If both curves were a straight line, a treatment of two parts water and one part acid, for instance, pumped in either 40 or 50 min. would result in a 33⅓ percent increase in channel widening. The widening would be in direct proportion to the ratio of fluid to acid. The slope of these curves must be considered, however, and points are taken corresponding to the time of contact, and were used to compile Table 2. One hundred percent is taken as the maximum channel size or enlargement and the theoretical loss in flowing capacity from the subnormal channel sizes is given.

Water or oil, designated as fluid, applies only to that which is forced into the formation behind the acid and does not apply to the casing or tubing contents.

Acid with no water or oil following into the formation produces the maximum, or 100 percent, channel enlargement if the pumping time equals the reaction time. This enlargement is nearest the well bore. Reducing the time to one-half allows 82 percent enlargement with dolomite and 88 percent with limestone. For one-fourth the reaction time, enlargement in dolomite is 26 percent and for limestone 75 percent. A higher speed of pumping can be maintained for limestone than for dolomite to obtain maximum channel enlargements that give the greatest production.

Nothing is gained by using different volumes of water or oil behind acid to obtain greater penetration. The increase to be expected with uniform permeability and porosity from increased radius depends upon the size of treatment and the varying ratios of fluid to acid, but the decreasing channel sizes due to use of fluid would carry much more oil or gas, as their flowing capacity is proportional to the square of the width.

The maximum widening with two parts injection fluid and one part acid is obtained when the time of pumping is equal to the reaction time, or 55 percent as much as with no fluid, in dolomite. This reduction will allow only 30 percent as much flow (Fig. 6), or a loss of 70 percent with the chance to gain 9 percent from the increased radius in 100 ft. of pay, 20 percent porosity, and 100 gal. of acid. If crevice conditions are present, using no fluid will automatically result in a greater radius being affected without restricting the increase in width; but if fluid is used, the crevice widening will be less with a greater increase in radius. Crevice conditions cannot be made by use of injection fluid. For limestone, which is faster acting, the reduction is to 80 percent, or a loss of 36 percent, and faster pumping will give detrimental results in either limestone or dolomite.

Even with successive stage treatments the increase in width of channels near the well bore will still be less than normal and if crevice conditions are present, less drop in velocity and decreased flow will result.

Time of placement, or pumping time, is the most important factor in treating, especially in dolomite. It can be too fast regardless of the method used.

Staging treatments by displacing the previous one with enough acid and water or oil to displace it, approaches the maximum efficiency if fluid injection behind acid is desired. This is shown in the third section of Table 2. The full reaction time should be used, as it will result in only a small reduction in channel sizes with some chance for more production from a greater radius. The comparisons for increased production between channel size decrease and increased radius still hold, but the decrease in both cases is smaller. Pumping time is very important and if there is a question about the type formation, it is safer to assume it to be dolomite and act accordingly when working under a combined fluid and pump pressure of over 800 lb. per sq. in. At pressures less than this, any well can be acidized quickly, because the reaction rate is much faster under a lower pressure and in practice the acid will not be placed much before the reaction time is completed. An increase in permeability will also have been obtained, which was the object in acidizing.

Maximum enlargement of channels that will permit maximum production is obtained with acid displaced from the well bore in the time corresponding to the rate of reaction. If the rate of production with maximum enlargement of channels is assumed to be 100 percent, the percent increase in production corresponding to the percent increase in channel widening up to the maximum would be as shown in Fig. 6. The curve in Fig. 6 also shows the decrease in production if channel widening is below normal due to any of the conditions heretofore discussed.

Thus if the pumping time for a dolomite treatment was 15 min. instead of 50 min., the time of contact near the well bore would allow only 52 percent of the acid to be used (Fig. 5). The limestone removal or channel widening would then be 52 percent of normal. This would give only 27 percent expected increase in production compared to the maximum possible increase, which can be called 100 percent, if the full 50 min. were used and the greatest efficiency of acid reaction was obtained near the well bore.

Water-washing for gas wells treated with a water load should follow the same principles as when using a compressor. The water should penetrate nearly to the same point as the acid. If a stage treatment of 5000 gal. of water and 8000 gal. of 15-percent acid is used, the wash then should approximate 13,000 gal. forced out into the formation. There is no point in using a weak-acid wash instead of plain water between stages; it would be of advantage only in flocculating the mud in the hole at the beginning of the treatment.

In discussing penetration and theoretical gain in production from acidizing oil wells previously in this article the figures given would apply if a pumping time of 40 min. for limestone and 50 min. for dolomite were taken.

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*These figures are based on the widely-used 6" square kelly with the 3½" bore vs. the 6⅝" hexagonal kelly with 4½" bore. Because it is the maximum dimension that governs the selection of a kelly size, the 6⅜" hexagonal (across-corner dimension 7¾") is comparable to—in fact, is actually ⅛" *smaller* in its limiting dimension than the 6" square kelly (across-corner dimension 7⅞"). *In other comparable sizes, Hex Kellys offer proportionate advantages.*

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This procedure results in maximum channel widening, which is assumed to be 100 percent. Fig. 3 shows a general longitudinal section of a channel; the 21.2 percent widening is taken as the maximum, or 100 percent, widening that could be obtained.

If 20 min. pumping time is taken for limestone and 25 min. for dolomite, the channel widening is only 88 percent and 82 percent respectively (see Table 2). The increase in flowing capacity will be $(.88)^2$ and $(.82)^2$ or 77.0 percent and 67 percent respectively. In dolomite the production increase, 67 percent of 67 bbl., would be 45 bbl. and in limestone a 77.0 percent increase would be 52 bbl., making the total production 145 bbl., or 152 bbl. respectively, instead of 167 bbl.

For a 10-min. and a 12-min. pumping period, the channel widening is only 33 percent and 75 percent respectively. The increase in barrels for dolomite would be $(.33)^2$ or .1089; and 10.89 percent of 67 bbl. is about 7½ bbl., or an increase to 107½ bbl.

For limestone the increase would be $(76)^2$ or .58; and 58 percent of 67 bbl. is 39 bbl., or an increase to 139 bbl.

If two parts oil or water are injected behind acid in 40 min. for limestone and 50 min. for dolomite, the channel widening is only 80 percent and 55 percent respectively.

$(.80)^2$, or 64 percent of 67 bbl. = 43 bbl., or a total increase to 143 bbl. for limestone.

$(.55)^2$, or 30 percent of 67 bbl. = 20 bbl., or a total increase to 120 bbl. for dolomite.

Assume that 5000 gal. of acid were used, followed by 10,000 gal. of water or oil, or a total of 15,000 gal., the penetration would be 80 in. × 1.9, or 152 in., or 12⅔ ft. The expected increase from this increased radius of penetration would be 89 percent, or an increase to 189 bbl. But in dolomite, the decrease in channel widening would reduce this to 30 percent, or 27 bbl. In limestone, it would be 64 percent or 57 bbl. The total production would be 127 and 157 bbl. respectively. Thus more production is lost than gained by injecting fluid behind the acid to push the acid out farther into the formation.

Although an increase of 89 percent could be expected from the increased radius of penetration by pushing the acid farther into the formation with fluid, this procedure actually results in an increase of only 64 percent in limestone and 30 percent in dolomite.

If the time of pumping is speeded to 10 min. and 12 min. in each case, the channel widening is only 10 percent more for dolomite and 65 percent more for limestone. These differences are due to differences in rate of reaction with plain acid under pressure (see points on curves Fig. 5). For dolomite, then, $(.10)^2 = .01$, or 1 percent more production could be expected; and for limestone, $(.54)^2 = .28$, or 28 percent more production could be expected.

This means a much further reduction in flowing capacity and very aptly shows the dual effect of faster pumping time plus the use of a large volume of fluid.

Small increases in production to be expected, such as 1 percent or 10.89 percent, are no doubt somewhat lower than would actually occur, as there will be some mechanical erosion and speeded reaction from faster movement and agitation of the acid; but the indicated extremes are so far apart that the proper procedure will be quite apparent.

The greatest efficiency is obtained by placing any size acid shot, in stages or otherwise, in either 40 min. or 50 min., and by just displacing it out into the formation, where possible. If there is a vacuum created during the injection of acid into the formation, permeability has been obtained, and pumping may then be as fast as desired. Otherwise, the pumping time should be controlled.

Much too little attention has been paid in the past to the effect of pumping time. Speed of pumping has been emphasized and demanded when in reality most work in the field has been too fast for best results. Rate of pumping can be checked and adjusted for any size of acid shot where pressure conditions prevail and the treatment completed at the proper time.

Attempts to speed rate of reaction have been made in the past by heating the acid either before or after entering the well. Such practices were applied to slow-acting dolomites. Controlling the rate of pumping is a simple means of allowing sufficient time for complete reaction of the acid. It will result in proper enlargement of the channels.

Acidizing Siliceous Formations

There has been a natural tendency to extend the use of acid in wells that were not producing from a true limestone or dolomitic formation. The question has arisen regarding how much carbonate must be present in a formation to permit increase in permeability by the use of acid.

Experience has shown that formations of a siliceous character and high rock pressure are benefited more by acidizing than similar formations of low rock pressure if the existing permeability is actually obscured by carbonate deposits. Formations having a 3 to 10 percent solubility have been helped in some cases and not in others.

New wells of this type may be helped by flocculating and removing the mud that has prevented natural flow. Most muds contain enough carbonate to permit a chemical reaction that breaks down and destroys the adhesive properties, permitting the mud to be circulated from the well.

Many wells in true sandstone formations, especially in the Gulf Coast area, are completed by setting pipe to bottom and gun-perforating. Compression of the walls of the bullet hole may restrict the flow of oil into the hole. Action of acid to only a slight degree will usually cause enough disintegration to permit the free flow of oil into the well. Sandstone formations may also contain some carbonate; when they do, their permeability may be increased by an acid treatment.

Old sand wells making some water

TABLE 2

Ratio		Dolomite			Limestone		
Acid	Fluid	Pumping time, min.	Size channels, percent	Percent loss in capacity	Pumping time, min.	Size channels, percent	Percent loss in capacity
1	None	50	100	None	40	100	None
1	None	25	82	32.8	20	88	22.5
1	None	12	26	93.25	10	75	43.8
				Reaction			
1	1	50	82	32.8	40	89	21.8
1	2	50	55	69.8	40	80	36.0
1	1½	25	68	53.8	20	77	40.6
1	1	25	42	82.4	20	75	43.8
1	2	25	25	93.75	20	68	53.8
1	1	12	20	96.0	10	68	53.8
1	2	12	10	99.0	10	65	57.7
1,000	None	50	100	None	40	100	None
4,000	1,000	50	97	6.0	40	96	8.0
8,000	5,000	50	93 (avg.)	13.5	40	96 (avg.)	8.0
10,000							
16,000							
1	None	25	82	32.8	20	88	22.5
4,000	1,000	25	69	52.5	20	83	31.1
8,000	5,000	25	59	65.2	20	80	36.0
10,000			(Avg.)			(Avg.)	
16,000							
1	None	12	26	93.25	10	75	43.8
4,000	1,000	12	27	92.7	10	72	48.1
8,000	5,000	12	28	92.15	10	73	46.7
10,000			(Avg.)			(Avg.)	
16,000							

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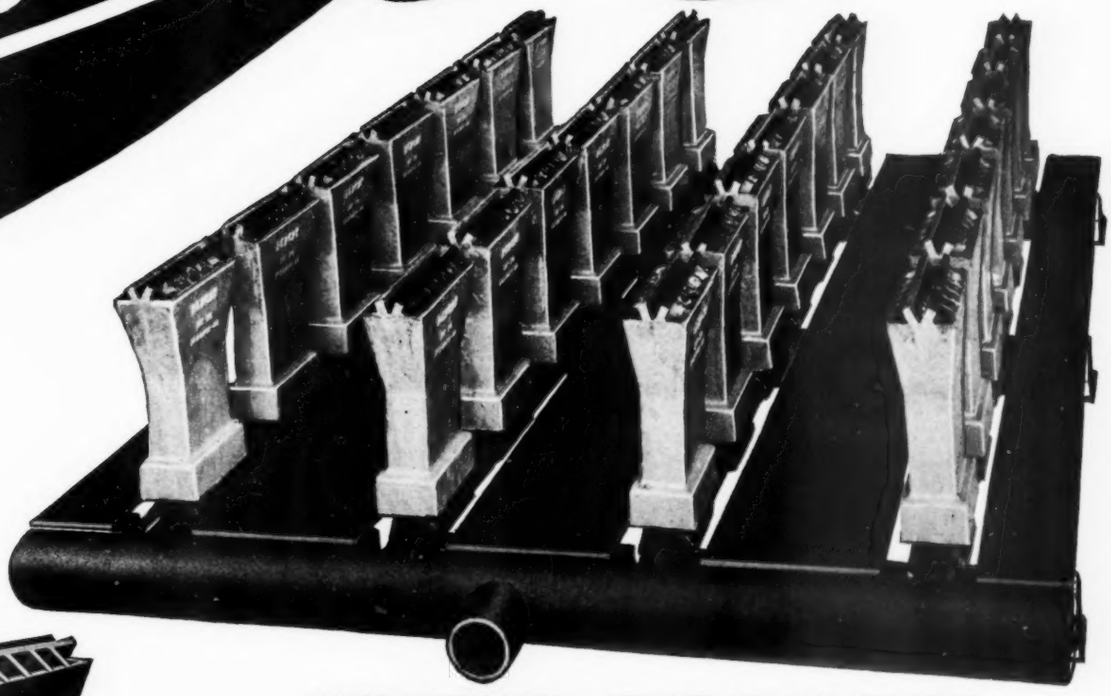

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Delivers more heat per dollar of fuel cost. Patented V-Shaped mantle spreads blue flame throughout entire fire-box. Produces maximum boiler horsepower, with less fuel, and without stack blowers. Installed in 30 minutes . . . cleaned in 5 minutes. Built in all standard boiler sizes. It's the oil country's No. 1 Steam-maker! Full details in your Composite Catalog, or Hunt Catalog.

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HUNT TOOL COMPANY
HOUSTON, TEXAS, U. S. A.

have declined because of calcareous deposits that are acid-soluble. Acidizing has improved the production of such wells by restoring the permeability. Wells containing screens or perforated liners have also been benefited by acidizing to remove the acid-soluble deposits. Benefits are also derived from the washing effect with fluid under pressure.

Considerable work has been done and many wells have been treated to overcome loss of permeability in sandstone wells as a result of clogging; but unless the deposits causing the clogging contain some acid-soluble material, it is impossible to accomplish as much as in limestone formations, which respond readily to acid treatment.

Addition Agents

Certain chemicals called addition agents are added to acid to increase the efficiency of the process. An acid with one addition agent is known as a penetrating acid.

Oil and gas together in the channels of a formation give a greater resistance to displacement by incoming acid than if there were no gas present. This is particularly true in finer channels of the capillary class and is known as the Jamin effect. This resistance to flow can be overcome with pumps so that ordinary acid can enter channels of a certain size but in so doing there will be many finer channels that would require much higher pressures for entrance and so will not be enlarged. This same condition of finer channels will also exist in a gas formation but there is no Jamin effect ahead of the acid.

If the formation is made up of more of this type of openings, or in other words, is tight, ordinary acid may require a distinctly higher pressure for entrance and the acid will be restricted to those openings that the pressure can overcome.

A penetrant, or addition agent, in an acid reduces resistance to flow. It increases the adhesive property, or wetting ability, of the acid, a property that enables the acid more easily to wet the walls of the channel and other surfaces of the formations. The relative change in the wetting ability of an acid can be demonstrated visually by spreading or flow-test comparisons on a glass plate. In pumping penetrating acid under pressure, leaks have been observed that did not occur with ordinary acid.

The wetting effect will also aid in the removal of the spent acid, but may be an unnecessary advantage if there has been proper widening of the channels by the acid treatment.

There will be no Jamin effect in the acid so long as the pressure on the acid exceeds 800 lb. per sq. in. If pressure is built up during injection of the acid into the formation and then drops during removal of the spent acid, the liberation of carbon dioxide from solution should help in expelling the spent product from the formation.

Another chemical, which is effective in two ways when mixed with acid, slows down the rate of reaction to an appreciable extent in dolomitic limestone. After a 30-min. interval, 95 percent of the reaction occurs with plain acid under pressure, but with the addition of this chemical, there is still 30 percent of the acid left to react in the next 35 minutes.

The other effect of this chemical is to hold gypsum in solution. Gypsum does not react with acid, but it does dissolve. After the acid is spent, the gypsum precipitates under normal conditions, and must be removed or plugging of the formation may result. It is especially desirable to prevent this happening in the gas fields of the Panhandle and Hugoton areas. The time element is also important when a gas compressor is used to displace acid. Delaying the chemical reaction will allow greater leeway in getting the acid in place before it is spent.

Non-emulsifying acid is probably the best improvement of a chemical nature for oil-well treating. Some of the tightness of new wells treated in the past has undoubtedly been due to emulsion formation and a greatly increased viscosity. Non-emulsifying acid decreases the amount of "bad" oil after an acid treatment and promotes a quicker, cleaner break in the storage tanks to pipe-line oil. Some wells have been plugged-off by acidizing because the emulsion caused more resistance than the formation pressure would overcome. A preliminary check to determine emulsion formation is one of the most important steps in an acid job.

☆ ☆ ☆

To Establish Depots for Oil-Country Tubular Goods

Fourteen oil-country tubular goods depots will be established throughout the United States by the third quarter of 1943 to meet emergency needs of wildcat operators, Petroleum Administrator for War Harold L. Ickes has announced.

Administrator Ickes described the emergency-depot plan as one of the important steps taken to stimulate wildcat operations.

The Administrator said:

"The importance of wildcat operations has been stressed time and again. To meet war-time petroleum requirements, at least 4500 wildcat wells should be drilled this year. Wildcat operations thus far have not been proceeding at this rate.

"Wildcat operators cannot begin drilling unless they have sufficient materials in reserve for use in wells that are completed. However, the materials situation is such that it is not possible to keep many strings of pipe lying idle unnecessarily.

"The depot plan will meet the need for minimum stocks of materials that will be available immediately when required for wildcat and emergency purposes."

Highlights of the plan, which was approved by the War Production Board, follow:

1. An aggregate of 20,000 tons of rolled oil-country tubular goods will be kept on hand at steel mills for emergency use by operators who drill less than 40,000 ft. annually. This material will be set aside for these smaller operators because they cannot project their future needs far in advance. Larger operators are able to plan their materials requirements, because of the large volume of exploratory work conducted by them each year, and these operators are required to apply in advance for the materials they will need for each succeeding quarter of the year.

2. An aggregate of 10,000 tons of tubular goods will be kept in stock in 14 depots for emergency use by all wildcat operators.

3. Orders will not be filled from these emergency stockpiles unless the operator's request is approved by the PAW District Director of Production in the District in which the material will be used.

4. All materials in these stocks must be acquired under the terms of Preference Rating Order P-98-b.

Deputy Administrator Ralph K. Davies emphasized that establishment of the emergency depots did not mean that materials were becoming more abundant. On the contrary, he pointed out, the depots were set up to meet the materials shortage that resulted from increased production on all industrial fronts and to prevent any decline in wildcat operations because of the possibility of an inadequate supply of materials for emergency use.

ASK THE MAN ON THE LEASE

He *knows* the importance of efficiency in dehydration because emulsion treating is a practical part of his job. He knows whether the "service" rendered is genuine, or merely salesmanship. For a good, down-to-earth opinion on the emulsion treating problem, ask the man on the lease. Tret-O-lite's long list of satisfied customers is ample evidence that, in the great majority of cases, the field man's answer will be . . . "Tret-O-lite," for the best in dehydration.

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Manufacturing Chemists
WEBSTER GROVES, ST. LOUIS COUNTY, MO. • LOS ANGELES, CALIF.

Complete Service for Every Field

Oil is Ammunition • Treat it Right

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Quickly . . Easily . . with
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No. 3480. 100 c. c. machine. Cranks and heads interchangeable with 15 c. c. machines.

You can maintain your required speed for the period of the test with much less effort. Curtin centrifuges, proven world-wide, are heavy duty, rigidly constructed, and extremely simple in design. Illustrated bulletin, giving full details, available upon request.

W·H·CURTIN & CO. Inc.
HOUSTON U·S·A TEXAS

LAUGH WITH BARNEY

First Gal: They say that live wires are awfully dangerous when you're in the bathtub.

Second Frill: They don't bother me. I always lock the door.

* * *

Berry: I'm groping for words to express my love for you.

Mary: Well, do you think I have part of the dictionary tatooed on me?

* * *

He: Every time I make love to you it makes me a better man.

She: Well, you don't have to try to get to heaven in one night.

* * *

First Little M.: Why are you running 'round and 'round that cracker box?

Second Same: Well, it says, "Tear around here."

* * *

Mike: How much do you charge for funeral notices?

Newspaper Clerk: Thirty cents an inch.

Mike: Begorra, it's robbery. Me brother was six feet tall.

* * *

Rastus: Son say here in this letter that he's O. K. but can't tell whar he is.

Mandy: I knew that no account would get hisself lost.

* * *

The newly rich oil farmer, unable to write, deposited his first royalty check in the bank and arranged that his signature should be two crosses. Soon a check showed up signed with three crosses and the banker summoned the farmer for an explanation.

"Well my wife is gettin' into society," he explained, "and she thinks I should have a middle name."

* * *

Mr. Smart: A woman is judged by her company.

Mrs. Blunt: Yes, but not until after she has left.

* * *

"Come on, Liz, there's the air raid siren!"

"Wait a second. I got to go back and get my false teeth."

"What do you think they're dropping, sandwiches?"

* * *

Patient: How can I get rid of this cold?

Doctor: Take a log walk id the oped air. That's wad I bid for bide.

* * *

The bride tottered down the aisle on the arm of her father, who was wheeled in his armchair by three of his great-grandchildren. His hair was gray and thin, her sunken cheeks cracked in smiles as she nodded to friends and relatives.

The bridegroom was able to walk unaided, with the assistance of two stalwart mahogany crutches. His head was bald and shining and his store teeth chattered and clicked.

They were the two who waited until they could afford to get married.

* * *

He: I'm not feeling myself tonight.

She: You're telling me.

* * *

"All my life," said Betty to her girl friend, "I've been seeking the ideal man . . . and oh! . . . what a lot of fun I've had missing him!"

* * *

A doctor received a call late one night and on a lonely road quite a ways in the country his car broke down. The only life he could see was a light in a home in the distance. He walked to the house and rapped on the door. A very handsome young woman appeared. He explained his plight and asked if he could stay all night. She explained that she was a widow and lived alone, had only one bedroom, but that she would be glad to let him have it, and she would sleep on the lounge. He went to the room, took off his clothes, and went to bed. He had been there only a short time when the door opened slightly and a soft voice inquired: "Are you asleep?" He answered, "No." "Would you like to have a bedfellow tonight?" "Yes," he replied. "All right," she responded, "Another man's car has broken down and he wants to stay here tonight also, so I'll send him in."

* * *

Mamie: I've spent several evenings a week with the boss learning the business.

Janie: Has he found what you're best fitted for?

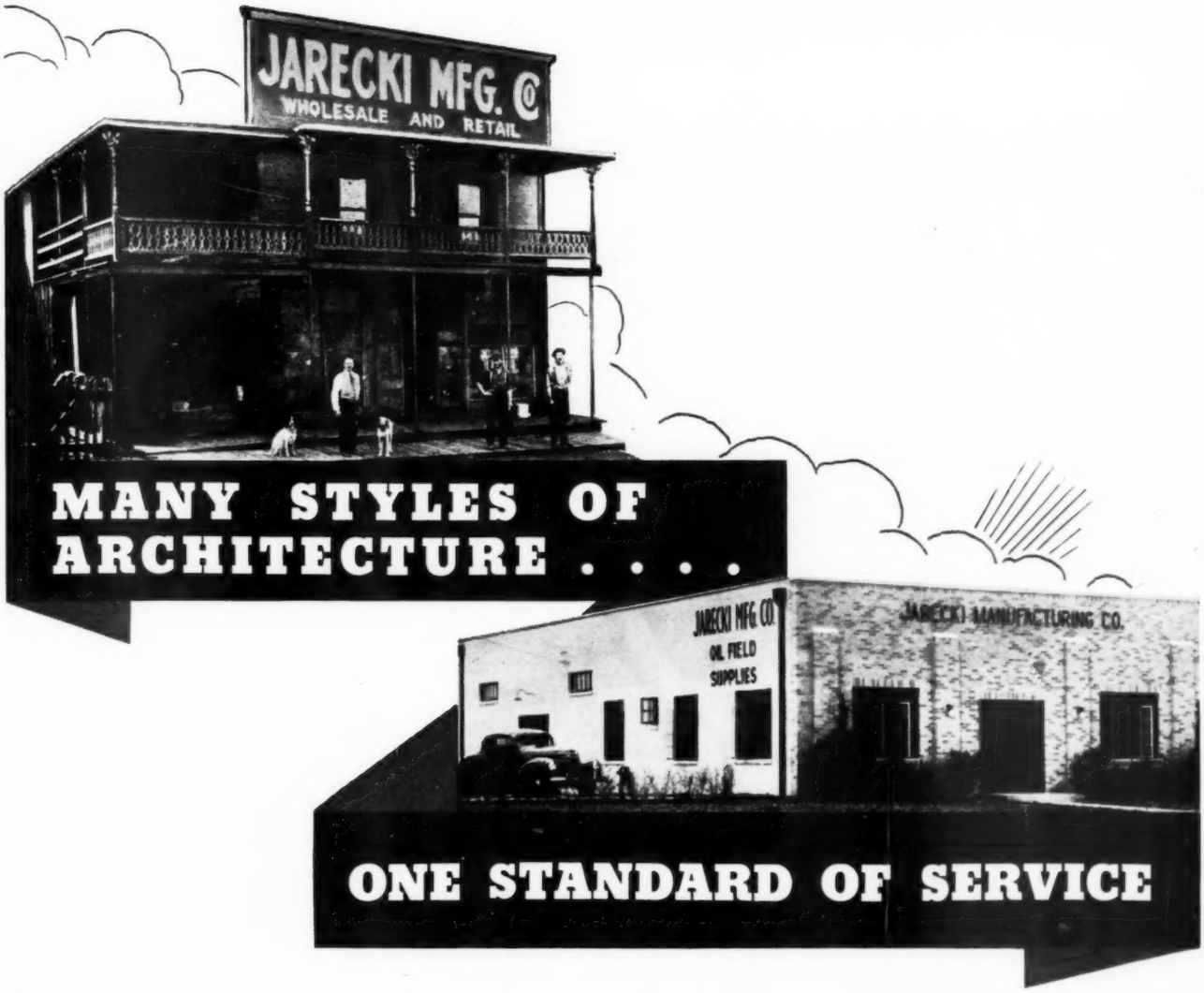
Mamie: Yes, but the old tightwad won't buy them for me.

* * *

The owner of the country newspaper went home to dinner, smiling radiantly.

"You must have had some good fortune this morning," greeted his wife.

"Indeed I did," announced the owner. "Jim Smith, who hasn't paid his subscription for ten years, came in and stopped his paper."



PICTURED at the left is what we believe to be the oldest establishment of its kind in the world — the Jarecki store at Clarendon, Pa.

Opened in 1883, it has been serving the needs of oil men ever since.

On the right is shown our Houston store, opened in more recent years — trim, compact, modern.

From an architectural standpoint, these stores are as different as the periods in which they were established. But from a service standpoint, they are identical. Each is a convenient local source for soundly designed and ruggedly built oil well supplies. Each is part of a chain that has grown with the industry it serves.

To succeeding generations of oil men, Jarecki oilfield stores are landmarks of helpful service as familiar and friendly in their field as the general store in crossroads communities — and serving just as important a purpose.

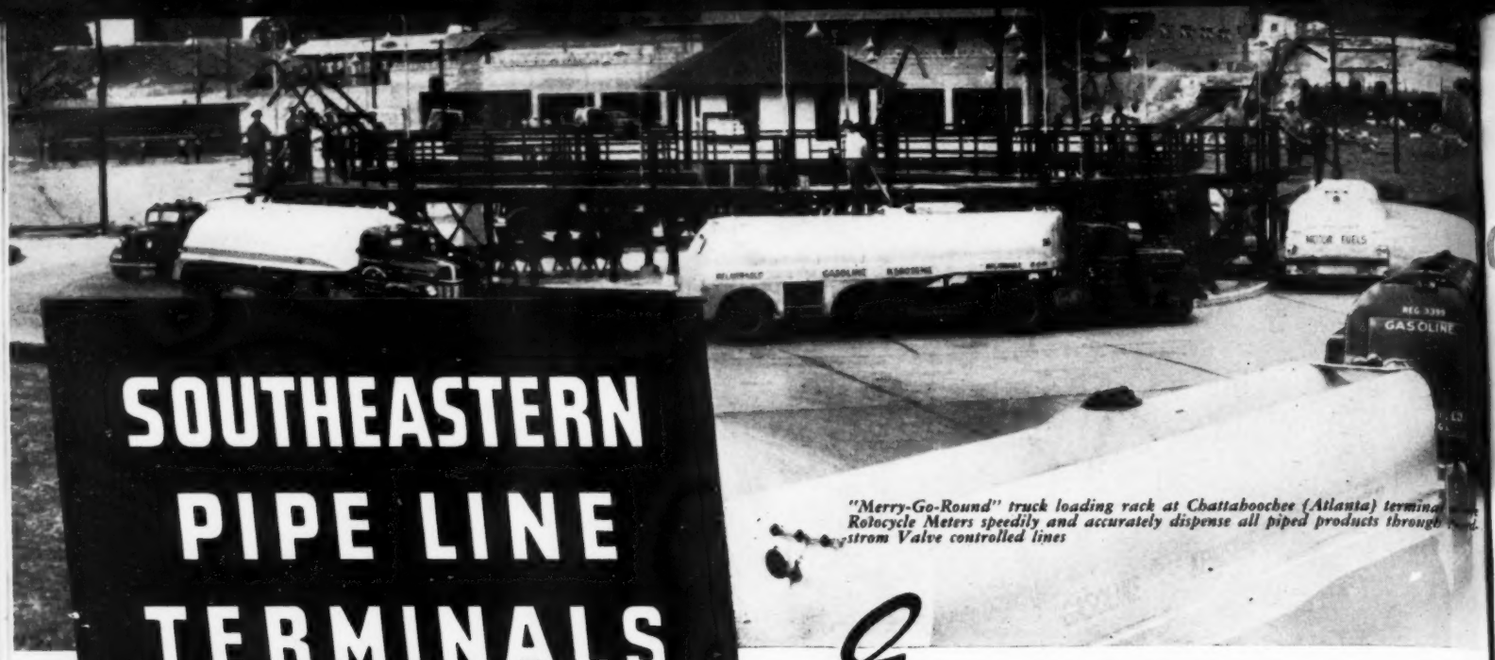
JARECKI

MANUFACTURING COMPANY

"Since 1852"

General Offices: St. Louis, Mo. Home Office and Factory: Erie, Pa., U.S.A. District Offices: Tulsa and Bartlesville, Okla.; Dallas and Houston, Texas; Mt. Pleasant, Mich.; Centralia, Ill.; Owensboro, Ky.

Branch Stores at All Important Places in the Oil Country

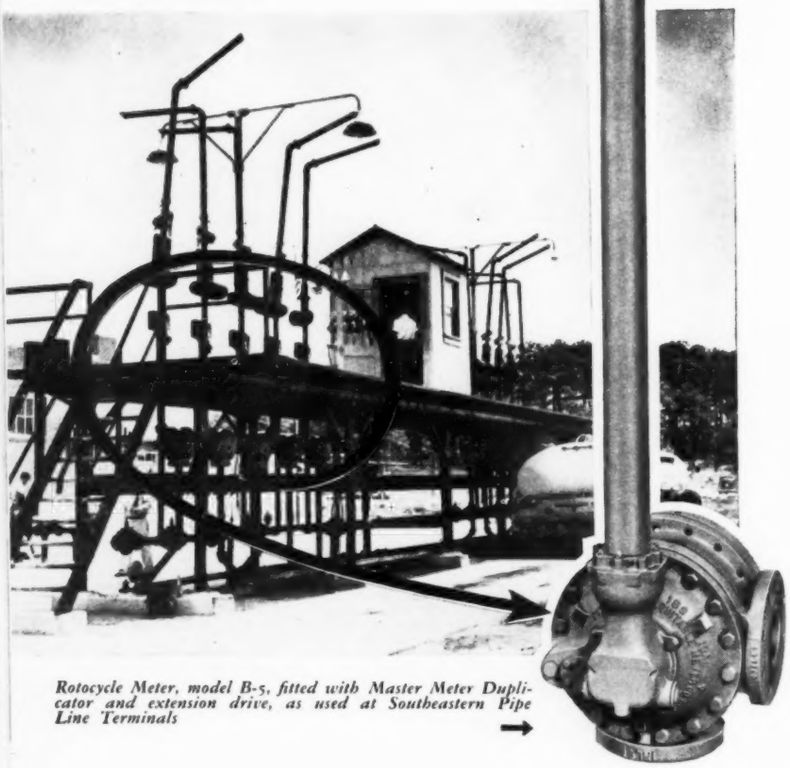


"Merry-Go-Round" truck loading rack at Chattahoochee (Atlanta) terminal. Rotocycle Meters speedily and accurately dispense all piped products through Nordstrom Valve controlled lines

SOUTHEASTERN PIPE LINE TERMINALS

Equipped with PITTSBURGH ROTOCYCLE METERS

Below: Standard four-truck loading rack, showing Rotocycle Meters installed under platform with extended printing type registers at operating level



Rotocycle Meter, model B-5, fitted with Master Meter Duplicator and extension drive, as used at Southeastern Pipe Line Terminals →

While the construction of the Southeastern Pipe Line was a peacetime project designed to improve transportation facilities for petroleum products within a limited area, the war has greatly increased its importance.

At the terminals of this strategic line the meter method of filling transport tankers has been adopted to increase the rapidity and efficiency of loading operations.

Pittsburgh Rotocycle Meters were chosen for this important job. Careful, studied engineering has provided a meter installation at each rack that permits the utmost in convenience and accessibility. The meters themselves are installed under the loading platforms with extension drives operating Master Meter Duplicators, with which each outlet is equipped. Special air eliminators and permanent proving equipment give assurance that the inherent accuracy of these meters is maintained at all times.

PITTSBURGH EQUITABLE METER COMPANY

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MERCO NORDSTROM VALVE COMPANY
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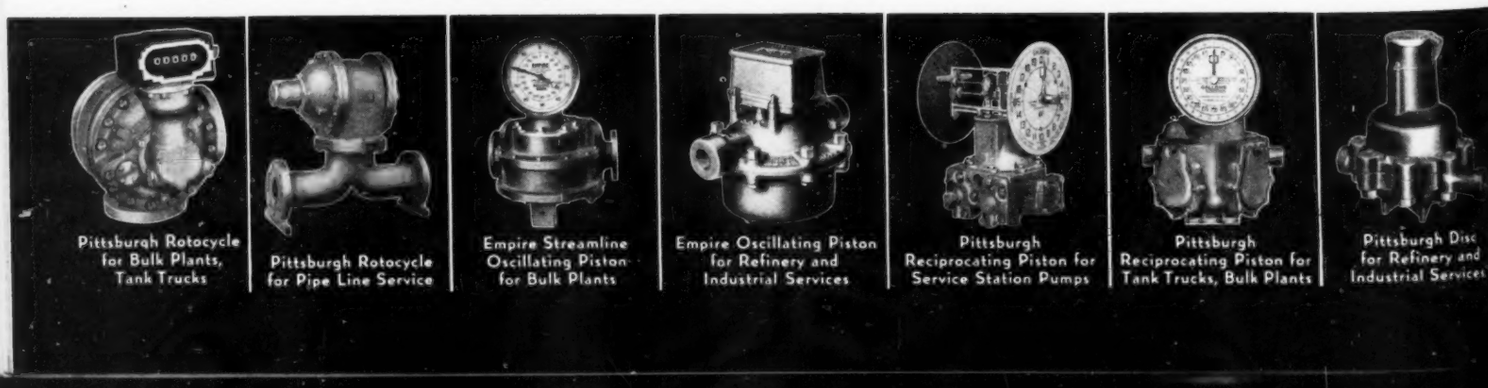
There's A Pittsburgh-National Meter for Every Type of Service



Pittsburgh Rotocycle for Bulk Plants, Tank Trucks

Pittsburgh Rotocycle for Pipe Line Service

Empire Streamline Oscillating Piston for Bulk Plants

Empire Oscillating Piston for Refinery and Industrial Services

Pittsburgh Reciprocating Piston for Service Station Pumps

Pittsburgh Reciprocating Piston for Tank Trucks, Bulk Plants

Pittsburgh Disc for Refinery and Industrial Services

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 73

A VALUABLE and regular feature of *The Petroleum Engineer,* the Continuous Tables, now in their seventh year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer.* Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously. More than 450 tables have been published.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

To readers of *The Petroleum Engineer,* who are only now becoming interested in the Continuous Tables, it should be pointed out that each table is assigned a filing or index number that conforms with the Dewey Decimal System of classification as modified and extended for the petroleum and related industries by L. C. Uren, professor of Petroleum Engineering at the University of California. This complete index has been published in earlier installments of the tables and is now available in booklet form at a cost of 50 cents per copy from *The Petroleum Engineer,* P. O. Box 1589, Dallas, Texas. Complete sets of the tables from the first installment to the present are also available in conjunction with subscriptions. General field classification numbers are as follows:

Nos. P000-P399—General

Nos. P400-P-499—Drilling

Nos. P500-P599—Production

Nos. P600-P699—Transportation and storage (includes pipe line)

Nos. P700-P799—Refining, including

Nos. P770-P799—Natural Gasoline, which may be classified in a separate division as shown here if of special interest to the user

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2. Fuel consumption chart—gas, gasoline, and butane	P 422.344.	105	July
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4. Expansion of air-vapor mixtures in atmospheric storage tanks	P 640.13	101	July
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7. Vaporization equilibrium constants for isopentane	P 771.214.755.	111	July

*This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue, and 61-72, inclusive, in the June, 1943, issue.

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4. Hazard Wire Rope Division of American Chain and Cable Co., Inc.	106	July	P 422.344.
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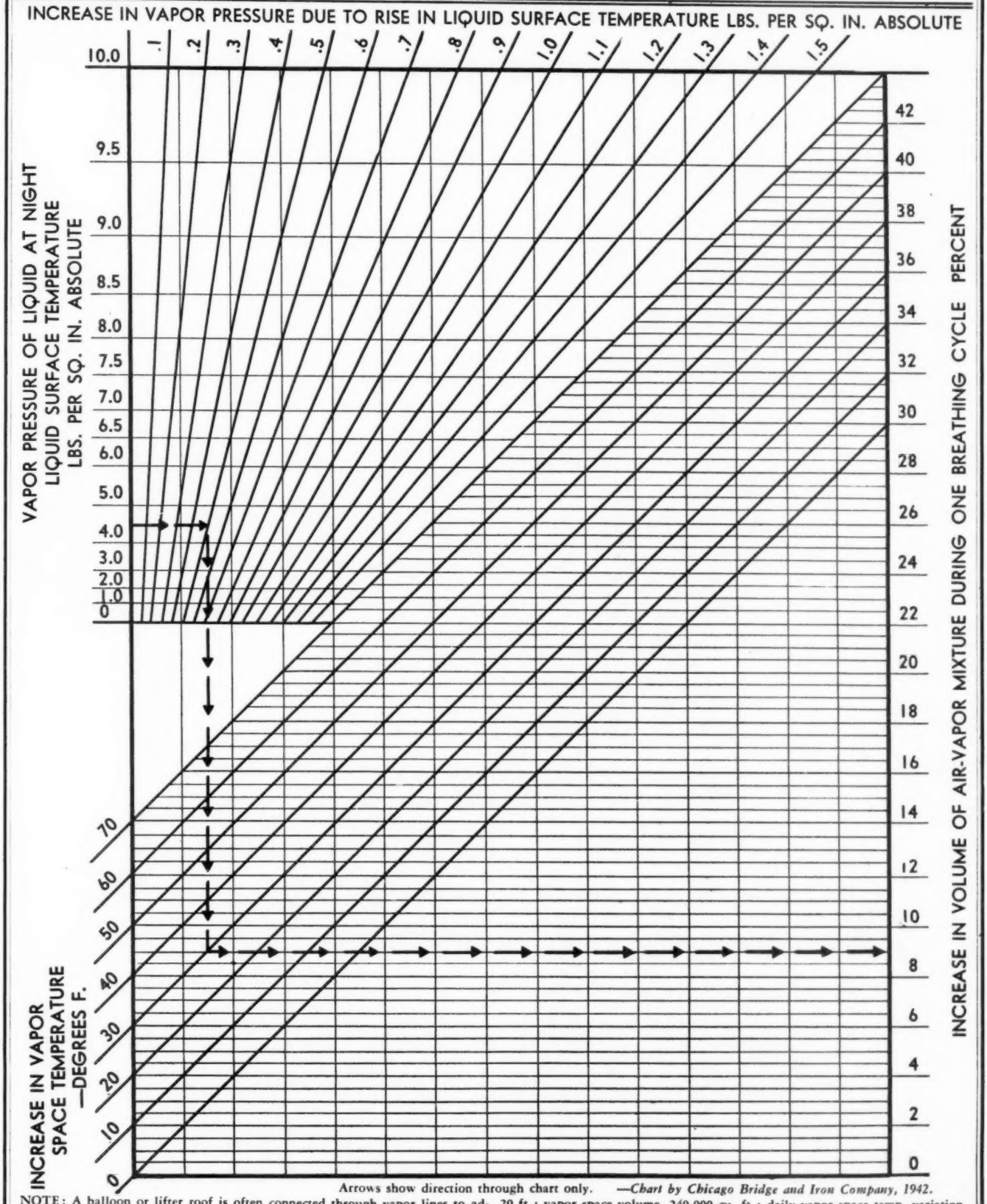
6. Maxim Silencer Company	108	July	P 640.1
7. Whitney Chain and Manufacturing Company	102	July	P 640.13

EXPANSION OF AIR-VAPOR MIXTURES IN ATMOSPHERIC STORAGE TANKS



Arrows show direction through chart only. —*Chart by Chicago Bridge and Iron Company, 1942.*

NOTE: A balloon or lifter roof is often connected through vapor lines to adjacent tanks with cone roofs, serving as a gasholder for the group of tanks. It is then necessary to estimate the probable expansion of the air-vapor mixture in all of the tanks under maximum temp. conditions to determine the volume of gasholder capacity required. This may be done by calculating each separately and totaling. *Example:* Find the volumetric expansion of the air-vapor mixture in an 80,000-bbl. storage tank if the product stored is 10 lb. R.V.P. gasoline; outage 20 ft.; vapor space volume, 240,000 cu. ft.; daily vapor space temp. variation, 40°F.; day liquid surface temp., 75°F.; and night liquid surface temp., 70°F. From Table P 640.1 vapor pressure at 75°F. is 6.9 lb. per sq. in. abs. and at 70°F. is 6.3 lb. per sq. in. abs. The increase in vapor pressure is 0.6 lb. Enter the above chart from the left at 6.3 lb., across to 0.6 lb. increase, down to 40° vapor space temp. variation, and then across to the right to the estimated expansion of 12.7 percent. The total expansion is 240,000 × 0.127 = 30,500 cu. ft.

Here's a product-and-service combination that can't be beaten . . . a team that's fully geared up to wartime oilfield needs: You can get the alloy-armored Whitney Chains you need to keep production up and shut-downs down . . . through Continental's service of supply and engineering assistance that gives you what you want, *right when you want it.*

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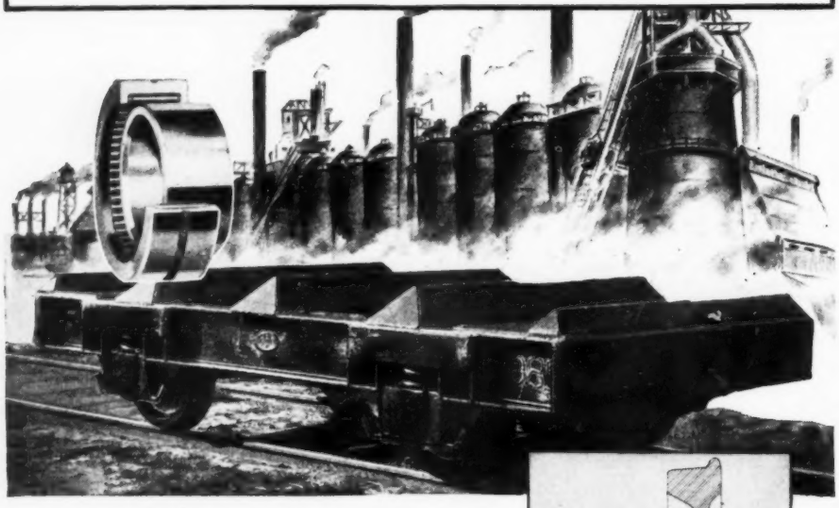
PROPERTIES OF ROUND WELDED CARBON STEEL TUBES

Outside diameter, in.		Wall thickness B.W.G & dec. in.	Inside diameter, in.	Section area, sq. in.	Weight lb. per ft.	Inside surface per lineal ft.		Lineal ft. per sq. ft. inside surface	Outside surface per lineal ft.		Lineal ft. per sq. ft. outside surface	Inside volume per lineal ft.			Lineal ft. per cu. ft. volume	Transverse area sq. in.	Displacement per lineal ft.		
						sq. in.	sq. ft.		sq. in.	sq. ft.		cu. in.	cu. ft.	gal.			cu. in.	cu. ft.	gal.
⅜	y	20(0.035)	0.305	0.0374	0.1274	11.50	0.0799	12.52	14.14	0.0982	10.19	0.0877	0.0005	0.0038	196.1	0.1104	1.325	0.0008	0.0057
	y	18(0.049)	0.277	0.0502	0.1706	10.44	0.0725	13.79	14.14	0.0982	10.19	0.0723	0.0004	0.0031	238.1	0.1104	1.325	0.0008	0.0057
½	y	20(0.035)	0.430	0.0511	0.1738	16.21	0.1126	8.881	18.85	0.1309	7.639	1.743	0.0010	0.0075	990.1	0.1963	2.356	0.0014	0.0105
	y	18(0.049)	0.402	0.0694	0.2360	15.15	0.1052	9.506				1.523	0.0009	0.0066	1136				
	y	16(0.065)	0.370	0.0888	0.3020	13.95	0.0969	10.32				1.290	0.0008	0.0056	1333				
⅝	y	20(0.035)	0.555	0.0649	0.2205	20.92	0.1453	6.882	23.56	0.1636	6.113	2.903	0.0017	0.0126	595.2	0.3068	2.682	0.0021	0.0157
	y	18(0.049)	0.527	0.0887	0.3014	19.87	0.1380	7.246				2.618	0.0015	0.0113	662.3				
	y	16(0.065)	0.495	0.1144	0.3888	18.66	0.1296	7.716				2.309	0.0013	0.0100	746.3				
	x	14(0.083)	0.459	0.1413	0.4805	17.30	0.1202	8.320				1.986	0.0011	0.0086	869.6				
¾	y	18(0.049)	0.652	0.1079	0.3668	24.58	0.1707	5.858	28.27	0.1964	5.092	4.007	0.0023	0.0173	431.0	0.4417	5.301	0.0031	0.2320
	x	16(0.065)	0.620	0.1399	0.4755	23.37	0.1623	6.161				3.623	0.0021	0.0157	476.2				
	x	14(0.083)	0.584	0.1739	0.5913	22.02	0.1529	6.540				3.214	0.0019	0.0139	537.6				
	x	13(0.095)	0.560	0.1955	0.6646	21.11	0.1466	6.821				2.956	0.0017	0.0128	584.8				
	x	12(0.109)	0.532	0.2195	0.7462	20.05	0.1393	7.179				2.667	0.0015	0.0115	649.4				
⅞	y	18(0.049)	0.777	0.1272	0.4323	29.29	0.2034	4.916	32.99	0.2291	4.365	5.690	0.0033	0.0246	304.0	0.6013	7.216	0.0042	0.0314
	x	16(0.065)	0.745	0.1654	0.5623	28.09	0.1950	5.128				5.231	0.0030	0.0227	330.0				
	x	14(0.083)	0.709	0.2065	0.7021	26.73	0.1856	5.388				4.738	0.0027	0.0205	365.0				
	x	13(0.095)	0.685	0.2328	0.7914	25.82	0.1793	5.577				4.422	0.0026	0.0191	390.6				
	x	12(0.109)	0.657	0.2623	0.8917	24.77	0.1720	5.814				4.068	0.0024	0.0176	425.5				
1	y	18(0.049)	0.902	0.1464	0.4977	34.00	0.2361	4.236	37.70	0.2618	3.820	7.668	0.0044	0.0332	225.2	0.7854	9.425	0.0055	0.0411
	x	16(0.065)	0.870	0.1909	0.6491	32.80	0.2278	4.390				7.134	0.0041	0.0309	242.1				
	x	14(0.083)	0.834	0.2391	0.8129	31.44	0.2183	4.581				6.555	0.0038	0.0284	263.9				
	x	13(0.095)	0.810	0.2701	0.9182	30.54	0.2121	4.715				6.184	0.0036	0.0268	279.3				
	x	12(0.109)	0.782	0.3051	1.037	29.48	0.2047	4.885				5.763	0.0033	0.0249	299.4				
1⅛	y	18(0.049)	1.027	0.1656	0.5631	38.72	0.2689	3.719	42.41	0.2945	3.396	10.640	0.0058	0.0430	173.9	0.9940	11.928	0.0069	0.0516
	x	16(0.065)	0.995	0.2165	0.7359	37.51	0.2605	3.839				9.331	0.0054	0.0404	185.2				
	x	14(0.083)	0.959	0.2717	0.9237	36.15	0.2511	3.982				8.668	0.0050	0.0375	199.6				
	x	13(0.095)	0.935	0.3074	1.045	35.25	0.2448	4.085				8.239	0.0048	0.0357	209.6				
	x	12(0.109)	0.907	0.2479	1.183	34.19	0.2375	4.211				7.753	0.0045	0.0309	222.7				
1¼	x	16(0.065)	1.120	0.2420	0.8226	42.22	0.2932	3.411	47.12	0.3273	3.055	11.822	0.0068	0.0512	146.2	1.2272	14.726	0.0085	0.0634
	x	14(0.083)	0.084	0.3043	1.034	40.87	0.2838	3.524				11.075	0.0064	0.0441	156.0				
	x	13(0.095)	1.060	0.3447	1.172	39.96	0.2775	3.604				10.590	0.0061	0.0458	163.1				
	z	12(0.109)	1.032	0.3907	1.328	38.91	0.2702	3.690				10.258	0.0058	0.0435	172.1				
1⅜	x	16(0.065)	1.245	0.2675	0.9094	46.94	0.3259	3.068	51.84	0.3600	2.778	14.569	0.0085	0.0632	118.3	1.4849	17.819	0.0130	0.0770
	x	14(0.083)	1.209	0.3369	1.145	45.58	0.3165	3.160				13.776	0.0080	0.0596	125.5				
	x	13(0.095)	1.185	0.3820	1.299	46.37	0.3102	3.224				13.235	0.0077	0.0572	130.7				
	z	12(0.109)	1.157	0.4335	1.474	43.62	0.3029	3.301				12.617	0.0073	0.0546	137.0				
	z	11(0.120)	1.135	0.4731	1.608	42.79	0.2971	3.366				12.141	0.0070	0.0526	142.2				
	z	10(0.034)	1.107	0.5227	1.776	41.53	0.2898	3.451				11.550	0.0067	0.0500	149.7				
1½	x	16(0.065)	1.370	0.2930	0.9962	51.65	0.3587	2.718	56.55	0.3927	2.546	17.690	0.0102	0.0766	97.75	1.767	21.205	0.0122	0.0913
	x	14(0.083)	1.334	0.3695	1.256	50.29	0.3492	2.864				16.772	0.0097	0.0726	130.1				
	x	13(0.095)	1.310	0.4193	1.426	49.39	0.3430	2.915				16.113	0.0093	0.0697	107.3				
	x	12(0.109)	1.282	0.4763	1.619	48.33	0.3356	2.980				15.490	0.0090	0.0670	111.6				
	x	11(0.120)	1.260	0.5203	1.769	47.50	0.3299	3.031				14.963	0.0087	0.0647	115.6				
	z	10(0.134)	1.232	0.5751	1.955	46.45	0.3225	3.101				14.305	0.0083	0.0619	121.1				
1⅝	x	16(0.065)	1.495	0.3186	1.083	56.36	0.3914	2.555	61.26	0.4254	2.351	21.06	0.0122	0.0913	81.97	2.074	24.887	0.0144	0.1077
	x	14(0.083)	1.459	0.4020	1.367	55.00	0.3820	2.618				20.062	0.0116	0.0868	86.21				
	x	13(0.095)	1.435	0.4566	1.552	54.10	0.3757	2.662				19.408	0.0112	0.0840	89.29				
	x	12(0.109)	1.407	0.5191	1.765	53.04	0.3684	2.714				18.658	0.0108	0.0808	92.60				
	x	11(0.120)	1.385	0.5674	1.929	52.21	0.3626	2.758				18.082	0.0105	0.0782	95.24				
	z	10(0.134)	1.357	0.6277	2.134	51.23	0.3553	2.815				17.354	0.0100	0.0751	99.60				
1¾	x	16(0.065)	1.620	0.3441	1.170	61.07	0.4241	2.358	65.97	0.4582	2.182	24.734	0.0143	0.1071	69.93	2.405	28.863	0.0167	0.1249
	x	14(0.083)	1.584	0.4346	1.478	59.72	0.4147	2.411				23.648	0.0137	0.1023	72.99				
	x	13(0.095)	1.560	0.4939	1.679	58.81	0.4084	2.449				22.936	0.0133	0.0993	75.18				
	x	12(0.109)	1.532	0.5620	1.910	57.75	0.4011	2.493				22.120	0.0128	0.0957	78.12				
	x	11(0.120)	1.510	0.6144	2.089	56.93	0.3953	2.530				21.489	0.0124	0.0930	80.64				
	z	10(0.134)	1.482	0.6803	2.313	55.87	0.3380	2.577				20.700	0.0120	0.0896	83.33				

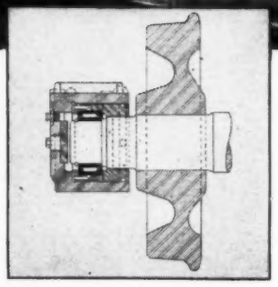
Note: x—indicates tubing made from either hot rolled or cold rolled strip as specified.
y—indicates tubing made from only cold rolled strip.
z—indicates tubing made from only hot rolled strip.

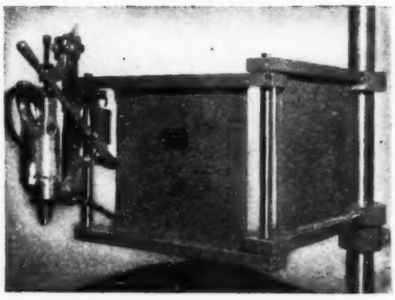
From *Manual of Welded Steel Tubing for Heat Exchanger and Condenser Use*, by permission of Formed Steel Tube Institute.

IN THE NEWS
WITH TORRINGTON—BANTAM

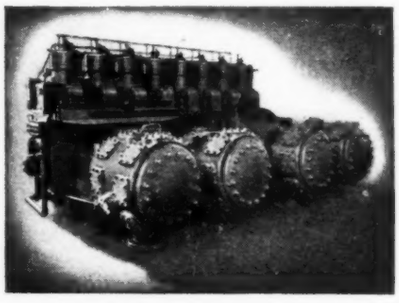


25 TONS OF CHARGE are carried by buggies like this one, to feed the steel furnaces at the Kaiser plant on the West Coast. Constructed by the American Car and Foundry Company, these cars employ Needle Bearings Type NCS on the axles, as shown in drawing. Efficient service is contributed by the low friction coefficient, high load capacity and effective lubrication method of these bearings.





DRILL PRESS OPERATION was obtained in this Black & Decker portable drill through the development of a radial arm attachment to speed production in an airplane factory. Compact arm design and flexibility over a wide radius of operation are combined with anti-friction performance through the use of NCS Needle Bearings—a typical case where the small size and high load capacity of these bearings have proven important advantages.



NO TIME FOR SHUTDOWNS in the oil industry—and these sturdy two-cycle, gas-engine-driven compressors built by Clark Bros. Co. Inc., are designed for service 24 hours a day. Type NCS Bearings are used in the wrist pins of the scavenging pump crossheads where the high load capacity of these bearings assures smooth, reliable performance. A catalog containing complete data on our line of Needle Bearings will be gladly sent upon request. Just write for Bulletin P-104.

NEEDLE BEARINGS FOR ALL PURPOSES, as well as special and standard anti-friction bearings of every type, are available from one source through the combined facilities of Bantam and Torrington. Here, too, is experienced skill to serve you in the unbiased selection or design of bearings to meet any requirement. For the utmost satisfaction in the solution of *your* bearing problems, TURN TO BANTAM

FARM PLANTING is made easier by this heavy-duty "Rototiller" which prepares seed beds all ready for planting in a single operation. Needle Rollers Type LN are assembled into economical, high-capacity anti-friction bearings on both ends of the connecting rods and on the wheels of this progressively designed unit. The rollers at the wrist pin end are projected beyond the connecting rod in such a way that they are constantly lubricated by a fog of oil from the crankcase. At the lower end, oil catches are used.

ARMY E NAVY

TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

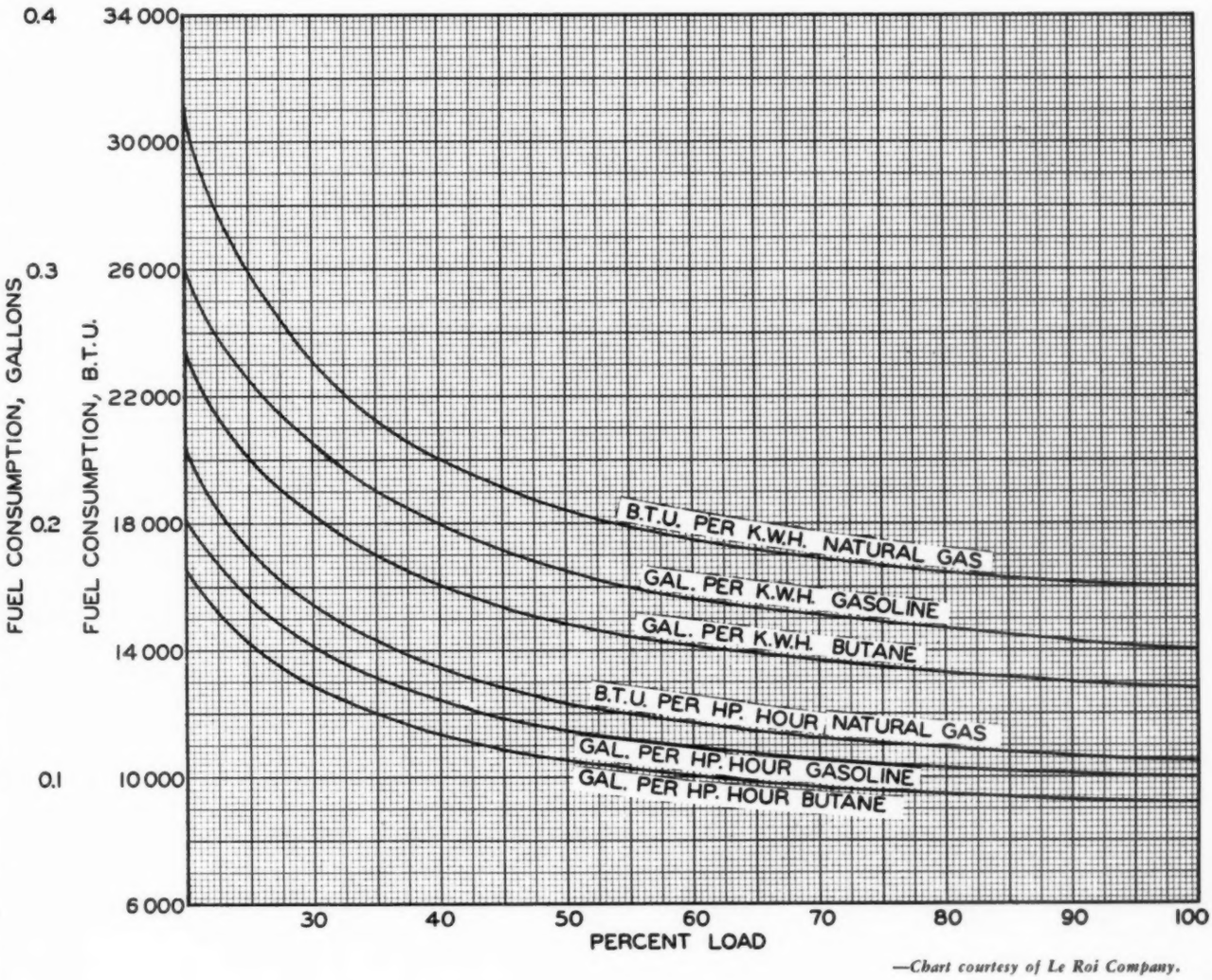
THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION

SOUTH BEND, INDIANA

FUEL CONSUMPTION CHART—GAS, GASOLINE, AND BUTANE

NOTE: The chart below is for general application in calculating fuel consumptions under different load conditions of engines using gas, gasoline, or butane as fuel.

1. K.W.H. = kilowatt hours at the switch board and 100 percent load in K.W. is $\frac{5}{8}$ of the maximum horsepower rating of engine.
2. Ordinates in B.t.u. refer to natural gas curves only.
3. Ordinates in gallons refer to gasoline and butane curves.
4. Consumption of natural gas with engine idling: B.t.u. per hour = 0.4 × r.p.m. × displacement in cu. in.
5. Consumption of gasoline per hour idling, gallons: multiply the r.p.m. by the displacement in cubic inches to the nearest whole number and the product of these by 35. In the result place the decimal point to the left of the seventh figure from the right. (R.p.m. × displacement × 35 × 10^{-7}). The constant to be used in figuring gasoline consumption per hour idling is shown as 35, however, it has been found from experiments that settings of carburetors can be obtained on some of the newer type carburetors that reduce the constant in this formula to as low as 28.



—Chart courtesy of Le Roi Company.

A Sheave Like This Will Ruin Wire Rope-

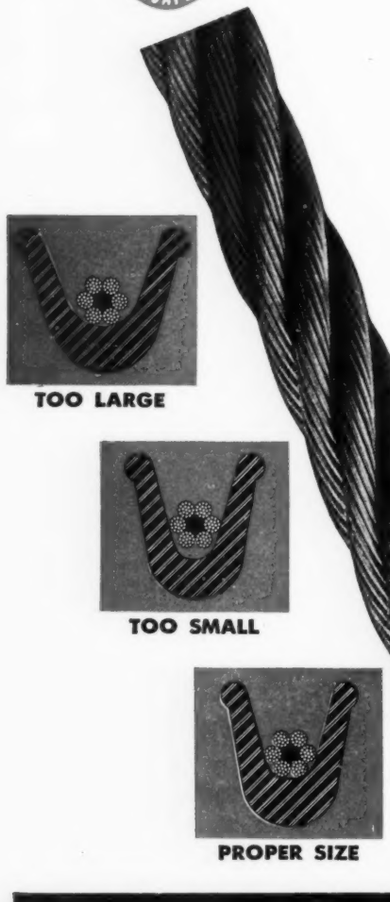
Yes, Even..

HAZARD **LAY·SET** *Preformed*

Never install a new wire rope on a worn sheave—to do so invites early failure. When the groove gets too wide, it permits the rope to flatten. . . . And don't try to run a new rope over a groove that is too narrow. That pinches the life out of it.

Before installing a wire rope (even the longer-wearing, easier-handling **Hazard LAY-SET Preformed**) carefully check the condition of your sheaves, using the standard sheave groove gauge. For calculating safe groove diameters, the following table gives the exact extent by which the groove diameter should exceed the diameter of the rope:

For ropes of the following diameters in inches	Groove diameter should be greater than rope by not less than the following fraction of an inch	Groove diameter should be greater than rope by not more than the following fraction of an inch
1/4 to 5/16	1/64	1/32
3/8 to 3/4	1/32	1/16
13/16 to 1-1/8	3/64	3/32
1-3/16 to 1-1/2	1/16	1/8
1-9/16 to 2-1/4	3/32	3/16
2-5/16 and larger	1/8	1/4
•	•	•



TOO LARGE

TOO SMALL

PROPER SIZE

Save critical steel by careful inspection and proper maintenance of *all* equipment and by using **Hazard LAY-SET Preformed** —the greater dollar-value rope. All Hazard ropes made of Improved Plow Steel are identified by the Green Strand.

HAZARD WIRE ROPE DIVISION

Wilkes-Barre, Pa., Chicago, Pittsburgh, Fort Worth, Houston, Wichita, San Francisco, Denver, Los Angeles

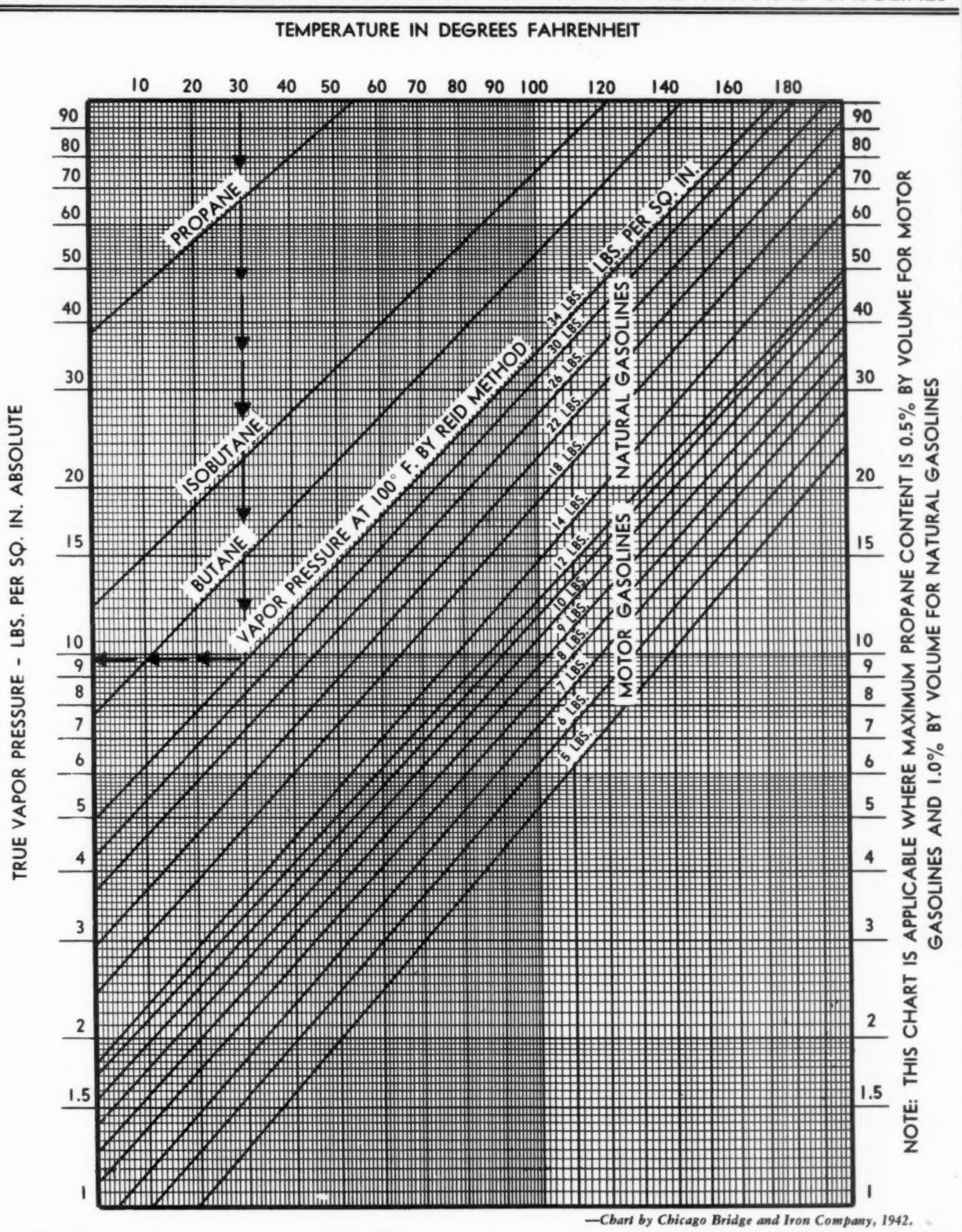
Distributors in all important oil field centers

AMERICAN CHAIN & CABLE COMPANY, INC.

BRIDGEPORT, CONNECTICUT

HAZARD **LAY·SET** *Preformed* **ROTARY LINES**

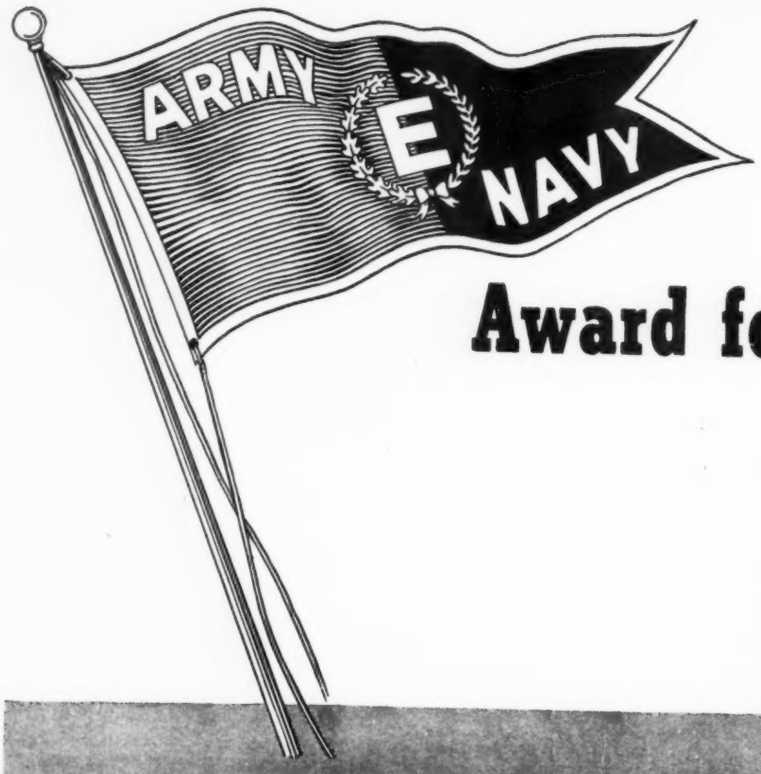
VAPOR PRESSURES VERSUS TEMPERATURES FOR MOTOR AND NATURAL GASOLINES


TEMPERATURE IN DEGREES FAHRENHEIT
10 20 30 40 50 60 70 80 90 100 120 140 160 180
TRUE VAPOR PRESSURE - LBS. PER SQ. IN. ABSOLUTE
90 80 70 60 50 40 30 20 15 10 9 8 7 6 5 4 3 2 1.5 1
PROPANE
ISOBUTANE
BUTANE
VAPOR PRESSURE AT 100° F. BY REID METHOD
LBS. PER SQ. IN.
34 LBS.
30 LBS.
26 LBS.
22 LBS.
18 LBS.
14 LBS.
12 LBS.
10 LBS.
9 LBS.
8 LBS.
7 LBS.
6 LBS.
5 LBS.
NATURAL GASOLINES
MOTOR GASOLINES
NOTE: THIS CHART IS APPLICABLE WHERE MAXIMUM PROPANE CONTENT IS 0.5% BY VOLUME FOR MOTOR GASOLINES AND 1.0% BY VOLUME FOR NATURAL GASOLINES

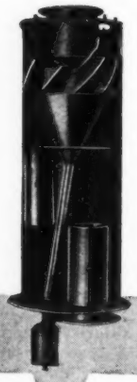
—Chart by Chicago Bridge and Iron Company, 1942.

NOTE: The actual vapor pressure of the liquid in a tank at tank temperature is one of the principal factors affecting the rate of evaporation loss. This vapor pressure may be read directly from the vapor pressure-temperature curves above provided the Reid Vapor pressure of the stored product and the tank liquid temperature are known.

In measuring the vapor pressure of a liquid by the Reid method, a portion of the sample is vaporized with the result that the Reid vapor pressure, reported in lb. per sq. in. abs. at 100 deg. F. is slightly lower than the true absolute vapor pressure at this temperature. Consequently, the Reid vapor pressure must be corrected to obtain the true vapor pressure. The proper correction was taken into account in preparing the above chart. The curves show the true vapor pressures at various liquid temperatures of motor and natural gasolines having Reid vapor pressures ranging from 5 to 34 lb. per sq. in.



Award for silence

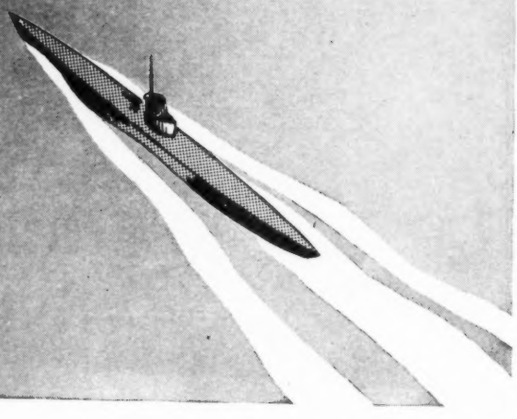


MAXIM

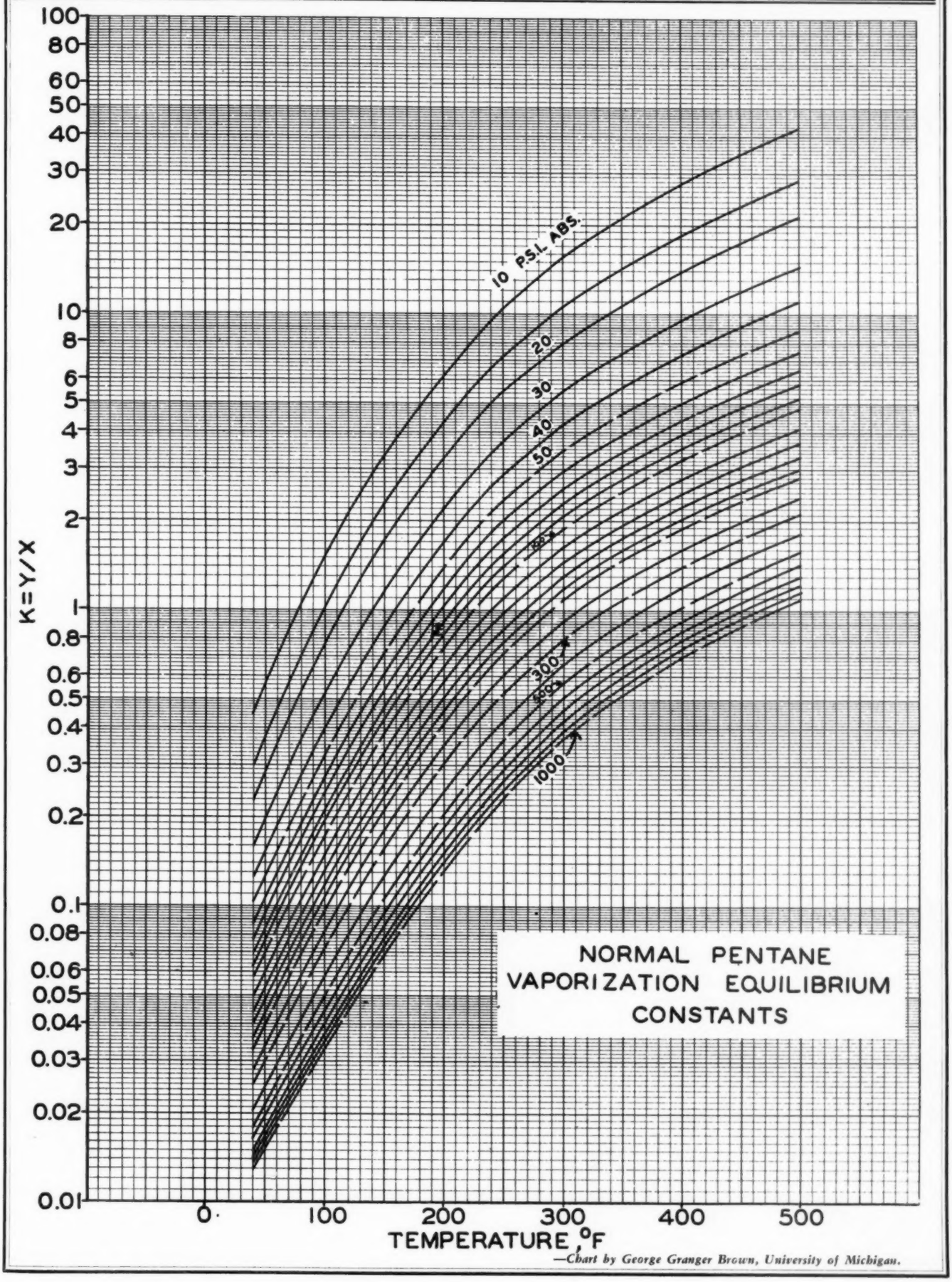
Silence, on the face of it, may seem a strange weapon of war . . . yet every day and every night at sea our ships "come through" because their position is not detected. For many this "positive protection" is due to Maxim Silencers which deaden engine noise to a whisper and trap all tell-tale sparks and embers.

For turning out this vital silencing equipment in ever increasing quantities, Maxim employees have earned the Army-Navy Production Award. Proud of this recognition, they are determined to better the record that earned it for them. The Maxim Silencer Co., 99 Homestead Ave., Hartford, Conn.

Maxim Waste Heat Units combine silencing, spark arresting and the utilization of waste exhaust heat to produce steam or hot water. Write for Bulletin WH-100.



VAPORIZATION EQUILIBRIUM CONSTANTS FOR NORMAL PENTANE

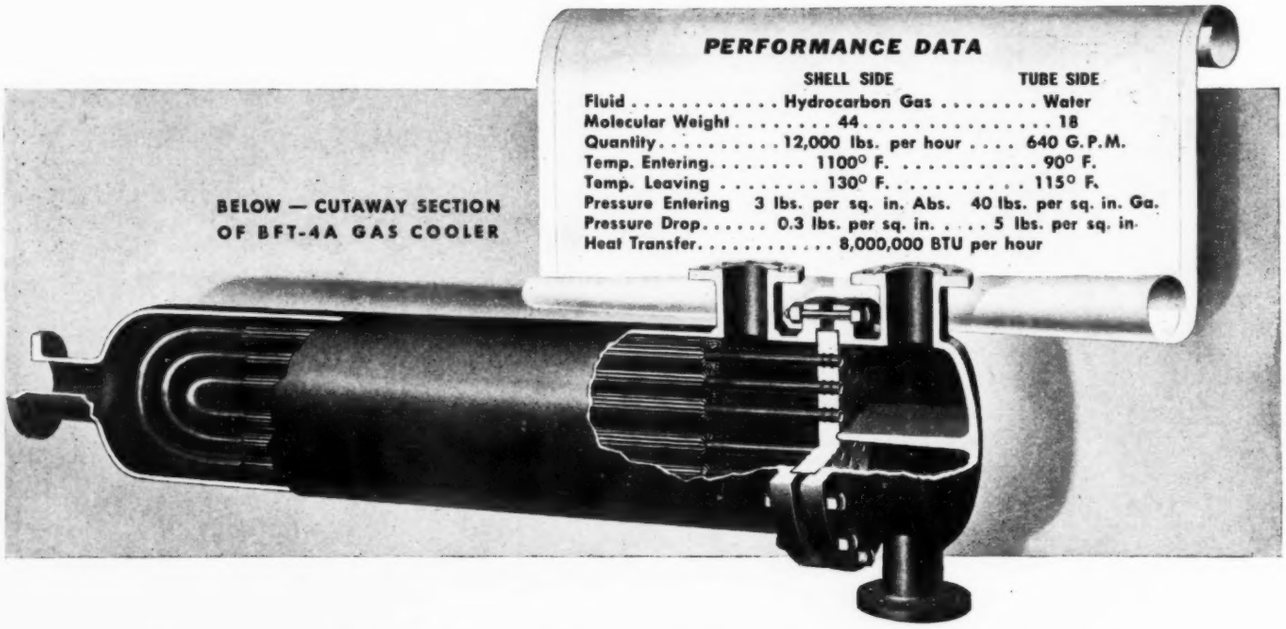


—Chart by George Granger Brown, University of Michigan.

YOU TOO CAN GET MUCH INCREASED EFFICIENCY WITH

BROWN FINTUBE HEAT EXCHANGERS

29" ID x 16' Overall Type BFT-4A Gas Cooler — in High Vacuum Service—Provides 3600 sq. ft. of Effective Surface—Transfers 8,000,000 BTU per Hour


PERFORMANCE DATA
SHELL SIDE
TUBE SIDE
Fluid . . . . . Hydrocarbon Gas . . . . . Water
Molecular Weight 44 18
Quantity . . . . . 12,000 lbs. per hour . . . . 640 G.P.M.
Temp. Entering . . . . . 1100° F. . . . . 90° F.
Temp. Leaving . . . . . 130° F. . . . . 115° F.
Pressure Entering 3 lbs. per sq. in. Abs. 40 lbs. per sq. in. Ga.
Pressure Drop . . . . . 0.3 lbs. per sq. in. . . . . 5 lbs. per sq. in.
Heat Transfer . . . . . 8,000,000 BTU per hour

BELOW — CUTAWAY SECTION OF BFT-4A GAS COOLER

Because Brown integrally bonded Fintubes, having the desired number and depth of fins, are used in effecting the heat transfer,—the primary and secondary tube surfaces of Brown Fintube Heat Exchangers can be proportioned to the transfer co-efficients of the materials being heated or cooled. This avoids the necessity of using hundreds, sometimes thousands of feet of bare tubing to satisfy the requirements of the commodity having the lower heat transfer co-efficient . . . It permits a fewer number or shorter Brown Fintubes to be used in a given heat transfer service than if plain bare tubes were used . . . And results in smaller shells, less pressure drop, less back pressure, and many other important savings in manufacturing, shipping, installation and maintenance costs.

For instance, the cooler described above, which required about 1900 lineal feet of fintube, would have required more than 11,000 lineal feet of plain bare tubing—a saving of more than 6700 lbs. of steel just in the tubing alone.

Brown Integrally Bonded Fintubes are used in all Brown Fintube Heat Exchangers—in exchangers made by most other manufacturers—and are available in a wide variety of sizes, and in mild carbon or special steels, for practically any heating or cooling requirement.

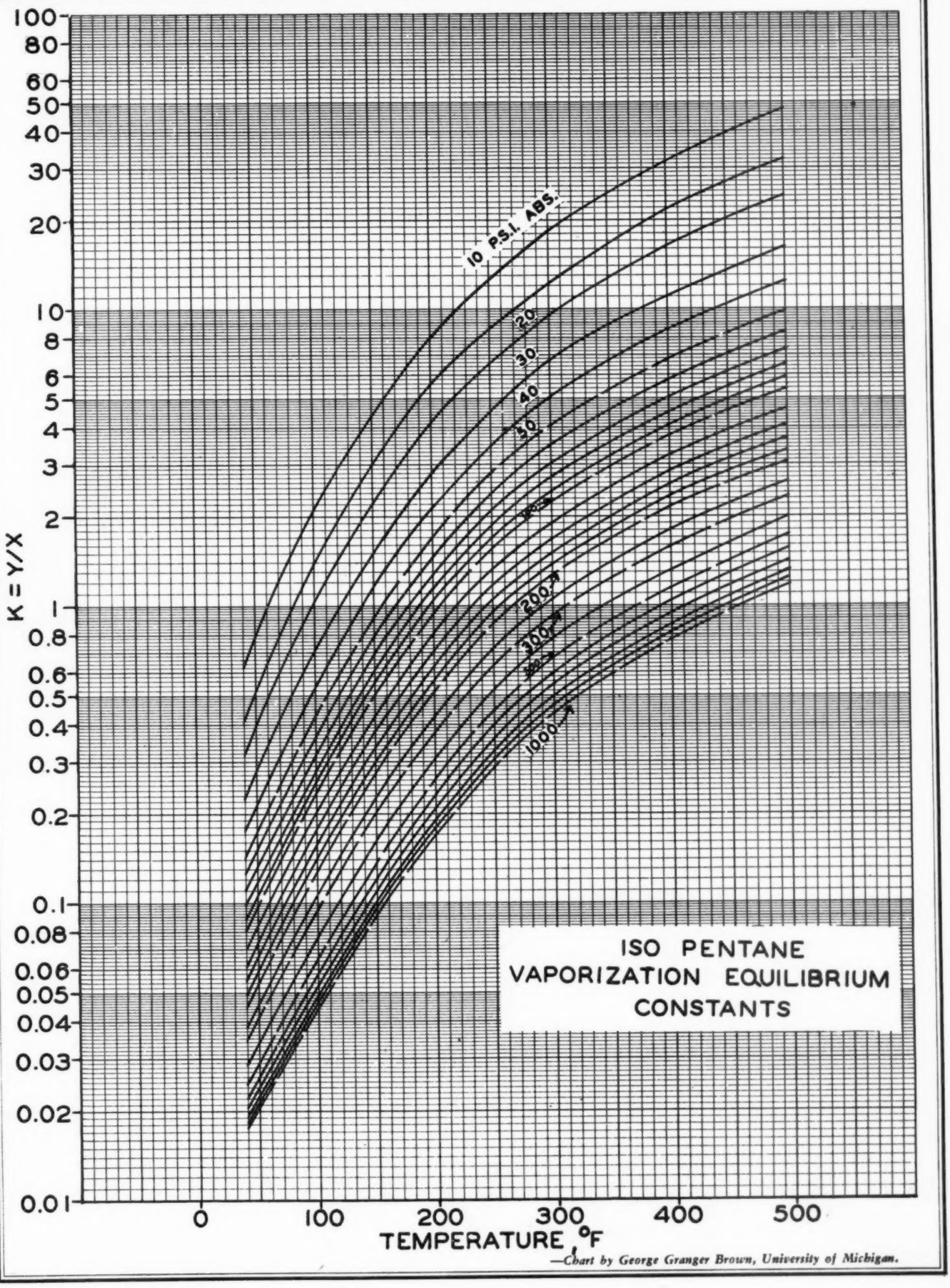
Six standard and many special types of Brown Fintube Heat Exchangers meet any requirement for effecting transfers between liquids and gases, or other commodities having unequal transfer co-efficients. Engineering assistance, recommendations, estimates, and descriptive literature furnished gladly. Let us quote on your requirements.

THE BROWN FINTUBE CO.

125 FILBERT STREET • ELYRIA, OHIO

MANUFACTURERS OF INTEGRALLY BONDED FINTUBES AND FINTUBE HEAT EXCHANGERS

VAPORIZATION EQUILIBRIUM CONSTANTS FOR *ISO*PENTANE



—Chart by George Granger Brown, University of Michigan.

TIPS ON VALVE TRIM
TO HELP KEEP PIPING ON THE JOB
How to Repair Valves
11 SIMPLE WAYS TO GET BETTER SERVICE FROM PIPING EQUIPMENT
Short-Cuts to Faster Piping Jobs
FOR SPECIFIERS
FOR PIPEFITTERS
HOW TO KEEP YOUR PLANT GOING WITHOUT INTERRUPTION!
HELPFUL HINTS ON CHOOSING VALVES FOR BETTER PIPING SERVICE

Ask for as many sets as you need. Requests filled as received while supply lasts.

YOU'LL FIND 'EM IN "PIPING POINTERS"

What to do when a tee can't be had—a globe valve—or a needed reducer? How to get jobs completed despite materials shortages? How to help themselves in emergencies is what today's piping maintenance men must learn if vital production lines are to be kept flowing.

For practical examples of wartime piping ingenuity, see Bulletin 6 of Crane "Piping Pointers." In the hands of your maintenance men, veterans as well as trainees, this bulletin can do much toward preventing delays on piping jobs. Anyone can use the maintenance short-cuts and the safe hints it gives on substitution of materials.

SENT FREE TO ANY PLANT

Aimed at speeding the war effort by helping all industry get better service from valves, fittings and piping, "Piping Pointers" are based on Crane Co.'s 88-year background in flow-control engineering. Your Crane Representative will gladly supply copies of Bulletin 6 and others in the series. Or, write to Crane Co., 836 S. Michigan Ave., Chicago, Ill.

ARMY E NAVY

CRANE VALVES

Static Press.
2100-2195 lb.

PRESSURE EXTENSIONS—ORIFICE METER CALCULATIONS

Differential pressure, in. of water	Static pressure, lb. per sq. in., ga.																				
	2100	2105	2110	2115	2120	2125	2130	2135	2140	2145	2150	2155	2160	2165	2170	2175	2180	2185	2190	2195
2	65.01	65.10	65.18	65.26	65.34	65.41	65.48	65.57	65.64	65.72	65.79	65.86	65.95	66.02	66.09	66.18	66.25	66.32	66.40	66.47
4	91.96	92.08	92.20	92.30	92.42	92.52	92.62	92.74	92.84	92.96	93.06	93.16	93.28	93.38	93.48	93.60	93.70	93.80	93.92	94.02
6	112.6	112.8	112.9	113.0	113.2	113.3	113.4	113.6	113.7	113.8	113.9	114.1	114.2	114.3	114.5	114.6	114.7	114.8	115.0	115.1
8	130.0	130.2	130.4	130.5	130.7	130.8	130.9	131.1	131.3	131.4	131.6	131.7	131.9	132.0	132.2	132.4	132.5	132.6	132.8	132.9
10	145.4	145.6	145.8	145.9	146.1	146.3	146.4	146.6	146.8	146.9	147.1	147.3	147.5	147.6	147.8	147.9	148.1	148.3	148.5	148.6
12	159.3	159.5	159.7	159.9	160.1	160.2	160.4	160.6	160.8	161.0	161.2	161.4	161.6	161.7	161.9	162.1	162.3	162.5	162.7	162.8
14	172.1	172.3	172.5	172.7	172.9	173.1	173.3	173.5	173.7	173.9	174.1	174.3	174.5	174.7	174.9	175.1	175.3	175.5	175.7	175.9
16	183.9	184.2	184.4	184.6	184.8	185.0	185.2	185.5	185.8	185.9	186.1	186.3	186.6	186.8	186.9	187.2	187.4	187.6	187.8	188.0
18	195.1	195.3	195.6	195.8	196.1	196.3	196.5	196.7	196.9	197.2	197.4	197.6	197.9	198.1	198.3	198.6	198.8	198.9	199.3	199.5
20	205.6	205.9	206.2	206.4	206.7	206.9	207.1	207.4	207.6	207.9	208.1	208.3	208.6	208.8	209.0	209.3	209.5	209.7	210.0	210.2
21	210.7	211.0	211.3	211.5	211.8	212.0	212.2	212.5	212.7	213.0	213.2	213.5	213.8	213.9	214.2	214.5	214.7	214.9	215.2	215.4
22	215.6	215.9	216.2	216.4	216.7	216.9	217.2	217.5	217.7	217.9	218.2	218.5	218.7	218.9	219.2	219.5	219.7	219.9	220.2	220.5
23	220.5	220.8	221.1	221.3	221.6	221.9	222.1	222.4	222.6	222.9	223.2	223.4	223.7	223.9	224.2	224.5	224.7	224.9	225.2	225.5
24	225.3	225.5	225.8	226.1	226.4	226.6	226.9	227.2	227.4	227.7	227.9	228.2	228.5	228.7	228.9	229.3	229.5	229.8	230.1	230.3
25	229.9	230.2	230.5	230.8	231.1	231.3	231.6	231.9	232.1	232.4	232.7	232.9	233.2	233.5	233.7	234.0	234.3	234.5	234.8	235.1
26	234.5	234.8	235.1	235.3	235.6	235.9	236.1	236.4	236.7	237.0	237.3	237.5	237.8	238.1	238.3	238.6	238.9	239.1	239.4	239.7
27	238.9	239.2	239.5	239.8	240.1	240.4	240.6	240.9	241.2	241.5	241.8	242.0	242.3	242.6	242.9	243.2	243.4	243.7	244.0	244.3
28	243.3	243.6	243.9	244.2	244.5	244.8	245.0	245.3	245.6	245.9	246.2	246.5	246.8	247.0	247.3	247.6	247.9	248.1	248.5	248.7
29	247.6	247.9	248.2	248.5	248.8	249.1	249.4	249.7	249.9	250.3	250.6	250.8	251.2	251.4	251.7	252.0	252.3	252.6	252.9	253.1
30	251.8	252.2	252.5	252.8	253.1	253.4	253.6	253.9	254.2	254.6	254.8	255.1	255.4	255.7	255.9	256.3	256.6	256.9	257.2	257.5
31	256.0	256.4	256.7	256.9	257.3	257.6	257.9	258.2	258.5	258.8	259.1	259.4	259.7	259.9	260.2	260.6	260.9	261.1	261.5	261.8
32	260.1	260.4	260.8	261.1	261.4	261.7	261.9	262.3	262.6	262.9	263.2	263.5	263.8	264.1	264.4	264.7	265.0	265.3	265.7	265.9
33	264.1	264.5	264.8	265.1	265.4	265.7	266.0	266.3	266.6	266.9	267.3	267.6	267.9	268.2	268.5	268.8	269.1	269.4	269.7	270.0
34	268.1	268.4	268.8	269.1	269.4	269.7	269.9	270.3	270.6	270.9	271.3	271.6	271.9	272.2	272.5	272.8	273.1	273.4	273.8	274.1
35	272.0	272.4	272.7	273.0	273.4	273.7	273.9	274.3	274.6	274.9	275.3	275.6	275.9	276.2	276.5	276.9	277.2	277.5	277.8	278.1
36	275.9	276.2	276.6	276.9	277.3	277.6	277.9	278.2	278.5	278.9	279.2	279.5	279.8	280.1	280.4	280.8	281.1	281.4	281.8	282.1
37	279.7	280.1	280.4	280.7	281.1	281.4	281.7	282.1	282.4	282.7	283.0	283.3	283.7	284.0	284.3	284.7	284.9	285.3	285.7	285.9
38	283.4	283.8	284.2	284.5	284.8	285.1	285.5	285.8	286.1	286.5	286.8	287.1	287.5	287.8	288.1	288.5	288.8	289.1	289.5	289.8
39	287.1	287.5	287.9	288.2	288.6	288.9	289.2	289.6	289.9	290.3	290.6	290.9	291.3	291.6	291.9	292.3	292.6	292.9	293.3	293.6
40	290.8	291.2	291.6	291.9	292.3	292.6	292.9	293.3	293.6	293.9	294.3	294.6	294.9	295.3	295.6	296.0	296.3	296.6	297.0	297.3
41	294.4	294.8	295.2	295.5	295.9	296.2	296.5	296.9	297.2	297.6	297.9	298.3	298.6	298.9	299.3	299.7	299.9	300.3	300.7	301.0
42	297.9	298.4	298.8	299.1	299.5	299.8	300.1	300.5	300.8	301.3	301.6	301.9	302.3	302.6	302.9	303.3	303.6	303.9	304.3	304.7
43	301.5	301.9	302.3	302.6	302.9	303.3	303.6	304.0	304.4	304.8	305.1	305.4	305.8	306.1	306.5	306.9	307.2	307.5	307.9	308.2
44	304.9	305.4	305.8	306.1	306.5	306.8	307.2	307.6	307.9	308.3	308.6	308.9	309.4	309.7	310.0	310.4	310.8	311.1	311.5	311.8
45	308.4	308.8	309.2	309.6	309.9	310.3	310.6	311.0	311.4	311.8	312.1	312.5	312.9	313.2	313.5	313.9	314.3	314.6	315.0	315.3
46	311.8	312.2	312.7	312.9	313.4	313.7	314.1	314.5	314.8	315.2	315.6	315.9	316.3	316.7	316.9	317.4	317.7	318.1	318.5	318.8
47	315.2	315.6	316.1	316.4	316.8	317.2	317.5	317.9	318.3	318.7	319.0	319.4	319.8	320.1	320.4	320.9	321.2	321.5	321.9	322.3
48	318.5	318.9	319.4	319.7	320.1	320.5	320.8	321.3	321.6	322.0	322.4	322.7	323.1	323.5	323.8	324.2	324.6	324.9	325.3	325.7
49	321.9	322.3	322.7	323.1	323.5	323.8	324.2	324.6	324.9	325.4	325.7	326.1	326.5	326.8	327.2	327.6	327.9	327.3	328.7	329.1
50	325.1	325.5	325.9	326.3	326.8	327.1	327.5	327.9	328.2	328.7	329.0	329.4	329.8	330.1	330.5	330.9	331.3	331.6	332.1	332.4
51	328.3	328.8	329.2	329.6	329.9	330.3	330.7	331.1	331.5	331.9	332.3	332.6	333.1	333.4	333.8	334.2	334.6	334.9	335.3	335.7
52	331.6	331.9	332.4	332.8	333.2	333.6	333.9	334.4	334.7	335.2	335.5	335.9	336.3	336.7	337.0	337.5	337.8	338.2	338.6	338.9
53	334.7	335.2	335.6	335.9	336.4	336.8	337.1	337.6	337.9	338.4	338.7	339.1	339.5	339.9	340.3	340.7	341.1	341.4	341.9	342.2
54	337.9	338.3	338.7	339.1	339.5	339.9	340.3	340.7	341.1	341.5	341.9	342.3	342.7	343.1	343.4	343.9	344.3	344.6	345.1	345.4
55	340.9	341.4	341.9	342.2	342.7	343.1	343.4	343.9	344.3	344.7	345.1	345.4	345.9	346.3	346.6	347.1	347.4	347.8	348.3	348.6
56	344.1	344.5	344.9	345.3	345.8	346.2	346.5	346.9	347.4	347.8	348.2	348.6	349.0	349.4	349.7	350.2	350.6	350.9	351.4	351.8
57	347.1	347.6	348.1	348.4	348.9	349.3	349.6	350.1	350.5	350.9	351.3	351.7	352.1	352.5	352.9	353.3	353.7	354.1	354.5	354.9
58	350.2	350.6	351.1	351.5	351.9	352.3	352.7	353.2	353.5	353.9	354.4	354.8	355.2	355.6	355.9	356.4	356.8	357.2	357.6	358.0
59	353.2	353.6	354.1	354.5	354.9	355.3	355.7	356.2	356.6	357.0	357.4	357.8	358.2	358.6	359.0	359.5	359.9	360.2	360.7	361.1
60	356.2	356.6	357.1	357.5	357.9	358.3	358.7	359.2	359.6	360.0	360.4	368.8	361.3	361.7	362.0	362.5	362.9	363.3	363.8	364.1
61	359.1	359.6	360.0	360.4	360.9	361.3	361.7	362.1	362.5	363.0	363.4	363.8	364.3	364.6	365.0	365.5	365.9	366.3	366.8	367.1
62	362.0	362.5	362.9	363.4	363.9	364.3	364.6	365.1	365.5	365.9	366.4	366.8	367.2	367.6	368.0	368.5	368.8	369.3	369.8	370.2
63	364.9	365.4	365.9	366.3	366.8	367.2	367.6	368.0	368.4	368.9	369.3	369.7	370.2	370.6	370.9	371.5	371.8	372.2	373.7	373.1
64	367.8	368.3	368.8	369.2	369.7	370.1	370.5	370.9	371.4	371.8	372.2	372.6	373.1	373.5	373.9	374.4	374.8	375.2	375.7	376.1
65	370.7	371.2	371.7	372.1	372.5	372.9	373.4	373.8	374.2	374.7	375.1	375.5	376.0	376.4	376.8	377.3	377.7	378.1	378.6	378.9
66	373.5	374.0	374.5	374.9	375.4	375.8	376.2	376.7	377.1	377.6	378.0	378.4	378.9	379.3	379.7	380.2	380.6	381.0	381.5	381.9
67	376.3	376.8	377.3	377.7	378.2	378.6	379.0	379.5	379.9	380.4	380.8	381.3	381.7	382.2	382.6	383.1	383.5	383.8	384.4	384.8
68	379.2	379.6	380.1	380.6	381.0	381.5	381.9	382.4	382.8	383.3	383.7	384.1	386.6	385.0	385.4	385.9	386.3	386.7	387.2	387.6
69	381.9	382.4	382.9	383.4	383.9	384.3	384.6	385.2	385.6	386.1	386.5	386.9	387.4	387.9	388.3	388.8	389.2	389.6	390.1	390.5
70	384.7	385.2	385.7	386.1	386.6	387.1	387.5	387.9	388.4	388.9	389.3	389.7	390.2	390.7	391.1	391.6	391.9	392.4	392.9	393.3
71	387.4	387.9	388.4	388.8	389.4	389.8	390.2	390.7	391.1	391.6	392.1	392.5	392.9	393.4	393.8	394.3	394.7	395.2	395.7	396.1
72	390.1	390.6	391.2	391.6	392.1	392.5	392.9	393.4	393.9	394.4	394.8	395.2	395.7	396.2	396.6	397.1	397.5	397.9	398.5	398.9
73	392.9	393.4	393.9	394.3	394.8	395.2	395.7	396.2	396.6	397.1	397.6	397.9	398.5	398.9	399.3	399.8	400.3	400.7	401.2	401.7
74	395.5	396.0	396.6	396.9	397.5	397.9	398.4	398.9	399.3	399.8	400.3	400.7	401.2	401.6	402.1	402.6	403.0	403.4	403.9	404.4
75	398.2	398.7	399.2	399.7	400.2	400.6	401.0	401.6	401.9	402.5	402.9	403.4	403.9	404.3	404.8	405.3	405.7	406.2	406.7	407.1
76	400.9	401.4	401.9	402.3	402.8	403.3	403.7	404.3	404.7	405.2	405.6	406.1	406.6	407.0	407.5	408.0	408.4	408.9	409.4	409.8
77	403.5	404.0	404.5	404.9	405.5	405.9	406.4	406.9	407.3	407.9	408.3	408.7	409.3	409.7	410.1	410.7	411.1	411.5	412.1	412.5
78	406.1	406.6	407.2	407.6	408.1	408.6	409.0	409.5	409.9	410.1	410.9	411.4	411.9	412.4	412.8	413.3	413.8	414.2	414.8	415.2
79	408.7	409.2	409.7	410.2	410.7	411.2	411.6	412.1	412.6	413.1	413.6	414.0	414.5	414.9	415.4	415.9	416.4	416.8	417.4	417.8
80	411.2	411.8	412.3	412.8	413.1	413.7	414.2	414.7	415.2	415.7	416.2	416.6	417.1	417.6	418.0	418.6	419.0	419.5	420.0	420.4
82	416.3	416.9	417.4	417.9	418.4	418.9	419.3	419.9	420.3	420.9	421.3	421.8	422.3	422.8	423.2	423.8	424.2	424.7	425.2	425.7
84	421.4	421.9	422.5	422.9	423.5	423.9	424.4	424.9	425.4	425.9	426.4	426.9	427.5	427.9	428.4	428.9	429.4	429.8	430.4	430.8
86	426.4	426.9	427.5	427.9	428.6	429.0	429.5	430.0	430.5	431.1	431.5	431.9	432.5	433.0	433.5	434.0	434.5	434.9	435.5	435.9
88	431.3	431.9	432.5	432.9	433.5	433.9	434.4	434.9	435.5	436.0	436.5	436.9	437.5	437.9	438.5	439.0	439.5	439.9	440.5	441.0
90	436.2	436.8	437.4	437.8	438.4	438.9	439.3	439.9	440.4	440.9	441.4	441.9	442.5	442.9	443.4	443.9	444.5	444.9	445.5	445.9
92	441.0	441.6	442.2	442.7	443.2	443.7	444.2	444.8	445.3	445.8	446.3	446.8	447.4	447.8	448.3	448.9	449.4	449.9	450.4	450.2
94	445.8	446.4	446.9	447.4	448.0	448.5	448.9	449.6	450.0	450.6	451.1	451.6	452.2	452.7	453.1	453.7	454.2	454.7	455.3	455.8
96	450.5	451.1	451.7	452.2	452.8	453.3	453.7	454.3	454.8	455.4	455.9	456.4	456.9	457.5	457.9	458.5	459.0	459.5	460.1	460.6
98	455.2	455.7	456.3	456.8	457.4	457.9	458.4	459.0	459.5	460.1	460.6	461.1	461.7	462.2	462.7	463.4	463.7	464.3	464.8	465.4
100	459.8	460.4	461.0	461.5	462.1	462.6	463.1	463.7	464.2	464.8	465.3	465.8	466.4	466.9	467.4	468.0	468.5	469.0	469.6	467.7

NOTE: Values given in body of table are products of the square roots of the static and differential pressures in lb. per sq. in., abs., and inches of water, respectively.

Absolute pressures are based on atmospheric pressure of 15 lb. per sq. in.

Table has been condensed to serve field men in approximating meter readings, intermediate readings for accurate measurements may be obtained from pressure extension books, usually available in district offices.

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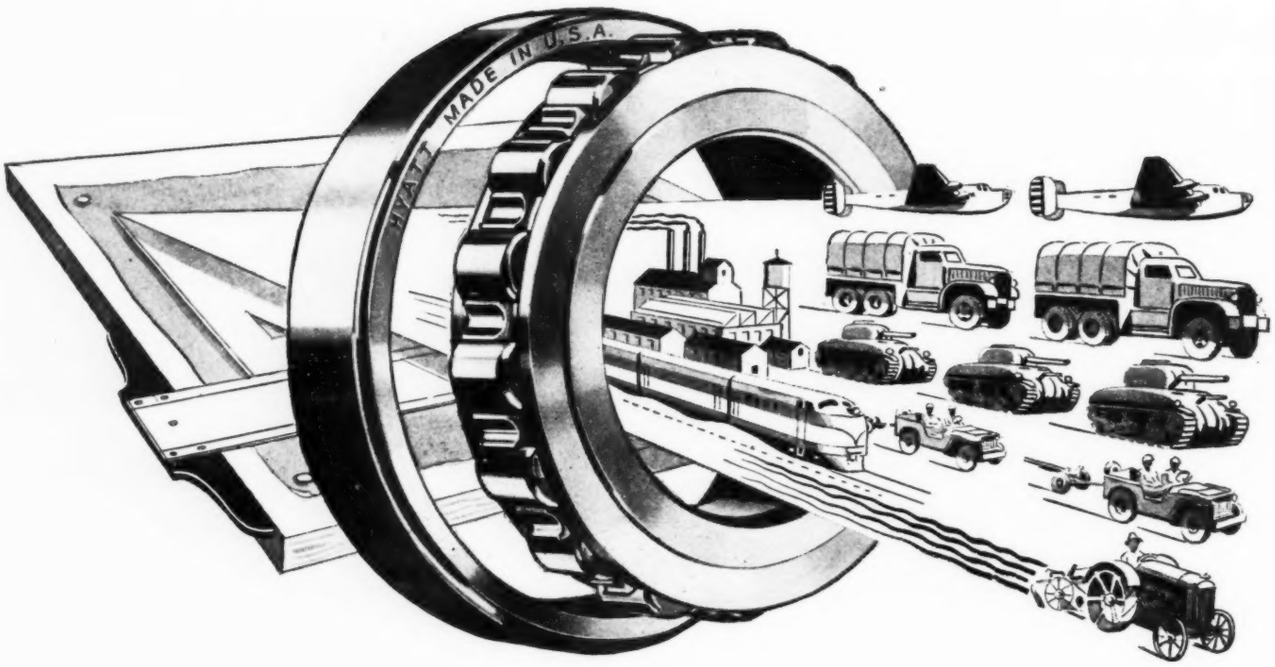

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☆ Organic colloidal admixture produces low filter cake permeability and improves mud characteristics

by Wallace A. Sawdon

Pacific Coast and Foreign Editor

CERTAIN fundamental characteristics must be present in all drilling fluids and specific characteristics must be given particular attention to meet varying hole conditions. Low filter cake permeability, however, is probably the most important single characteristic of a good drilling mud because upon it depend the low water loss and thin filter cake desirable for effective drilling operations in general and necessary for drilling through certain formations and for penetration of productive zone by rotary operations. The amount of permissible water loss is not always the same and mud engineers, either in the service of oil companies or manufacturers of mud materials, have been striving for a mud with water loss approaching zero and a means of maintaining that low water loss in the presence of salt water, anhydrite, gypsum, cement, or any water soluble electrolyte. Such a mud would be particularly advantageous when drilling through oil-bearing sands in order to prevent injury to the sands and contamination of cores; and would provide for drilling through certain formations that cause caving when even a small amount of water is permitted to pass beyond the face of the hole.

The attainment of low filter cake permeability in actual practice is not always easily accomplished. Generally speaking, it is necessary to have present at least a certain minimum concentration of gel-forming clay colloids, such as are provided by the mineral bentonite, and to maintain these colloids, together with the other suspended materials in the mud, in a state of complete or nearly complete deflocculation. In maintaining a mud in a deflocculated state, the adage is certainly true that an ounce of prevention is worth a pound of cure. In the particular environment of a drilling mud, prevention amounts to an avoidance of contamination of the mud with flocculating substances such as cement, salt, salt water, anhydrite, gypsum, etc., as well as an avoidance of drilling through an excess of mud-making formations.

Oil naturally does not always occur where these preventive measures can be used. Accordingly, it often turns out that conditions that permit maintaining mud in a good state of deflocculation simply cannot be obtained, and the desired low filter cake permeability cannot be achieved, even with the best chemical control when the colloids are inorganic. For example, in drilling through 1000 ft. of rock salt, corrective measures that are useful in treating salt contamination of a drilling mud at concentrations of up to, say, 1 percent by weight fail completely because the mud very quickly becomes completely saturated with sodium chloride.

Drilling muds belong to a class of substances known as colloidal dispersions. This results from the fact that the suspended materials, or at least a part of them, are in such a fine state of subdivision that their ratio of surface to volume is greatly exaggerated in comparison with materials in a more usual state. The state of such a colloidal suspension is, therefore, dependent upon the condition of the surface of the individual particles rather than upon any mass or bulk relationship such as govern ordinary chemical reactions. Thus, some colloidal suspensions owe their stability to the fact that all surfaces of the particles bear an electrical charge of like sign so that a mutual repulsion exists between all particles, which not only prevents flocculation with its loss of colloidal properties but also, in some cases, probably contributes to the structural viscosity observable in such suspensions. In the case of other colloidal suspensions, the attraction of the material of the colloidal particle for that of the liquid in which it is dispersed is so great that the surface of each colloidal particle becomes intimately and tenaciously covered with an adhering film of liquid, which is usually water. The individual particles are thus kept from flocculating because of the interposition of such a comparatively rigid film between the surfaces of the particles.

The two general types of colloids just described represent extremes and any single example of a colloidal dispersion may very well occupy an intermediate position with respect to the surface forces that contribute to its stability. Ordinary non-gel-forming clays probably belong a little more in the first class than they do in the second whereas gel-forming clays, despite their great avidity for water, are not completely dominated by hydration phenomena, so to speak, but are still governed, although to a minor extent, by electrical forces that in turn are dependent upon the nature and concentration of any soluble salts present.

Accordingly, when certain limits are reached in the amount of contaminating influences in the drilling mud, when it is no longer possible to neutralize or otherwise overcome such contaminants by means of chemical or mechanical treatment, and when these contaminating agents are of the nature of soluble salts that tend to flocculate any colloids dependent for their stability upon a relative absence of such soluble salts, one possible alternative is to use a colloidal material that not only is capable of yielding low filter cake permeability but also is relatively unaffected by electrical forces. In brief, a choice is to be made from those colloids belonging at the extreme end of the second class of colloids described above.

There are many such colloids that can be used with some degree of success but most of the available materials have major or minor drawbacks. For example, many colloids belonging to the class in question, although immune to large concentrations of salts, are not very good filter-cake permeability-decreasing agents. Again, some colloids will be both stable in the presence of salts and will give muds with good sealing qualities; but they will give too high a viscosity when used at effective concentrations, or may cause bad foaming of muds. Other materials, free or not free from these drawbacks, require the use of considerable extra equipment, such as is the case when certain starches are cooked up at a well before addition to the mud stream.

A commercially prepared starch has been developed to avoid as far as possible all the usual disadvantages of such colloids. It is now being supplied to the industry as a water-dispersible organic colloid under the trade name of "Im-

permex."[1] It is a white powder somewhat lighter in bulk density than ground bentonite and is added to the mud in the same maner as any clay without the use of any special equipment and without the application of heat. It is usually introduced into the fluid by means of the familiar cone and jet mixer that was first used in oil-well cementing. When added to an ordinary drilling mud, it reduces the water loss of the mud to very nearly the same low figure regardless of the initial water loss of the mud. For example, whether added to a mud of 20 cc. water loss A.P.I. or 100 cc. water loss A.P.I., approximately 4 lb. per bbl. generally results in a mud having a water loss of 8 to 10 cc., whereas 7 to 8 lb. per bbl. of mud reduces the water loss to less than 5 cc. A.P.I. By means of a technique described below, it is possible to add even larger amounts of organic colloid than those just mentioned and to obtain a drilling mud possessing a water loss of 1.5 cc. A.P.I. or below. Such a mud fluid is particularly useful in special applications, such as when caving is a problem or when coring must be done with minimum displacement of the fluid contents of the core. The typical water-loss reductions shown in Fig. 1 are obtained by the use of this fluid. Although values obtained with a saturated salt mud are shown, the results are not greatly different for other types of mud.

The material being an organic colloid, it therefore, in common with all other organic materials of a like nature, is subject to fermentation or similar microbiological degradation unless steps are taken to keep such decomposition from occurring. When it is used for the temporary treatment of a mud (such as when a fairly good mud has been used for drilling down to the producing sand and it is desired to reduce the water loss of the mud to just a few cubic centimeters for the purpose of drilling in) it is possible to use the material without taking any particular antidecomposition measures. Natural immunity to such decay, however, lasts only for two or three days and possibly even a shorter time in some districts, depending upon the natural microbiological flora of the clays, mixing water, and formations penetrated. Large salt concentrations materially assist in inhibiting mud decomposition although the action is not positive enough to be depended upon.

When operations of moderate duration are contemplated and only a relatively light treatment with the organic colloid is desired, there are several germicides that can be used with considerable success. These are generally of the nature of creosote, formaldehyde, chlorine, chlorinated phenols, certain copper and mercury organic compounds etc.

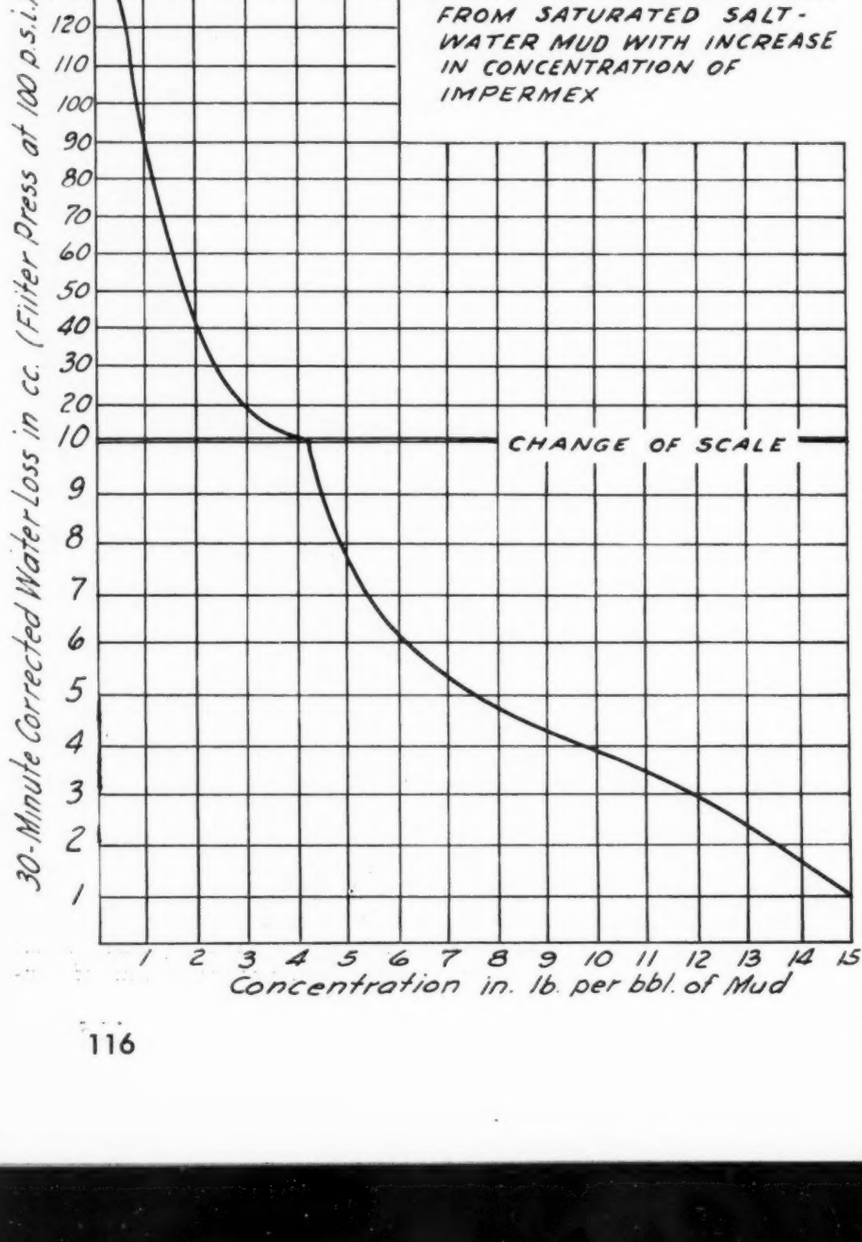
There has been found, however, one positive method of preventing all bacterial decomposition and, because of its certainty and simplicity, it is highly recommended for all uses except when adverse circumstances make its application impossible. This technique consists in raising the pH of the mud to a point between 11.5 and 12.3 and maintaining it within that range during the entire course of the drilling. This can be done with caustic soda or with other special alkalis that have been developed especially for the purpose.

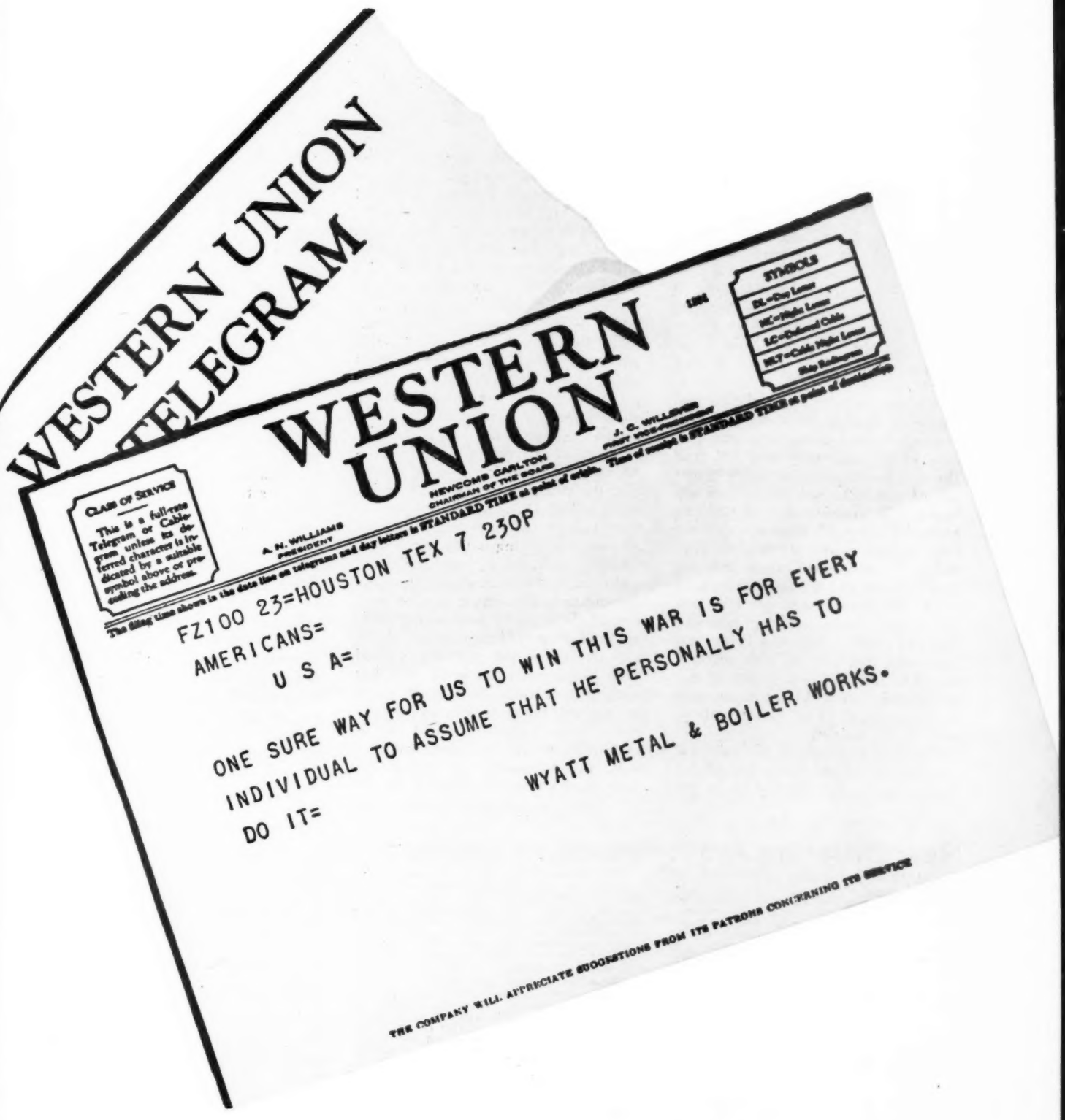
The initial amount of alkali necessary depends of course on the original pH and buffer capacity of the mud, which in turn is dependent not only upon the salts present but upon the particular clays contained therein. An addition of from one-fourth to two or three pounds of caustic soda (or its equivalent in certain other alkalis) is representative of the amounts commonly needed. It is recommended that in all cases the pH of the mud be raised before the organic colloid is added. Subsequent additions will tend to lower the pH slightly but this can be offset with only small additions of alkali. As time goes on it is necessary to add additional organic colloid and additional alkali in order to maintain the water loss at any desired low figure, as well as to maintain the pH in a range such that bacterial action is completely inhibited. The daily make-up amounts, however, are but a small fraction of the amounts used in the initial treatment.

At such high pH values it is possible to add very large quantities of the organic colloid without the production of a mud excessively thick in consistency. These muds are unusual in possessing a water loss of practically zero —actually from 0 to 2 cc. in 30 min. (A.P.I. test) in field practice. Although the measured viscosity of such

[1]A product of Baroid Sales Division, National Lead Company.

Fig. 1




WESTERN UNION TELEGRAM
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This is a full-rate Telegram or Cable-gram unless its deferred character is indicated by a suitable symbol above or preceding the address.
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a mud (in centipoises) is rather high, the gel strengths are low enough to make the mud just as pumpable as a normal mud.

Examples of Use

In a well in a Texas field it was desired to obtain the most reliable information possible from core analysis and drillstem tests and to make this possible it was decided to use a very low water-loss mud. As the mud would be in continuous service while drilling at least 5000 ft., stability and ease of control were important factors. By laboratory tests it was determined that somewhat more than half as much quebracho as caustic soda would be required with the native mud available and on the basis of the tests it was concluded that, to obtain a pH of 12 in the final mixture, a suitable base mud would consist of 800 bbl. of native mud, 200 bbl. of water, 2000 lb. of caustic soda, and 1250 lb. of quebracho.

Without interrupting the normal course of drilling operations the mud pits were jetted down to a total volume of approximately 800 bbl. and the addition of solutions of 50 lb. per bbl. of quebracho and caustic soda was begun. The viscosity and gel strength gradually increased, however, so for a time quebracho and water alone were added. The addition of caustic soda was then resumed and finally a solution of 75 lb. of caustic soda per bbl. was added. Drilling was continued with this high pH mud for two days before any Impermex was put in. This material was then introduced at a rate of approximately 50 bbl. per hour with weight material added at intervals to increase the weight.

The final mud had a pH of 11.8, viscosity of 29 cp., water loss of 2.4 cc. in 30 min. and weighed 10 lb. per gal. (75 lb. per cu. ft.). As drilling progressed over a period of weeks, the wall-building properties were maintained by the occasional addition of the organic colloid and fermentation was prevented by the regular addition of small amounts of caustic soda.

A smaller water loss was desired in a well in Kansas in order to procure cores with the minimum amount of flushing and absorption so that core analysis could be used to evaluate the reserve production of the sand in a water-flood project. The mud to be treated had a weight of 9.8 lb. per gal. (74 lb. per cu. ft.), viscosity of 29 sec. A.P.I., 94 cc. water loss, 7/32-in. filter cake, 7.5 pH and 1.1 percent salt by weight. Caustic soda was added to the system while circulating until a pH of 12.5 was obtained. This was maintained for several round trips of the fluid, after which Impermex was added at a rate of 50 lb. every 3 to 5 min. A small amount of prepared bentonite was then added to increase viscosity and impart gel strength. The treated mud was of approximately the same weight as the original drilling fluid, had a viscosity of 75 cp., initial gel of 8 grams and a 10-min. gel of 14 g., a water loss of only 0.5 cc., a filter cake of 1/64-in., and a pH of 12.5.

The use of very low water-loss mud to overcome caving is illustrated by a deep test in Texas that was drilling at 6800 ft. in Pennsylvanian shales and was caving badly because of acute wetting of the shales by poor quality drilling mud. Prepared bentonite and chemical treatment had provided a mud with 14 cc. water loss in 30 min. but with this comparatively small water loss the well failed to clean up and necessary coring operations could not be performed. A very low water-loss mud was then determined on to stop the shale from caving by keeping all the water possible out of the formation.

After making pilot tests on the mud being used, the initial pit treatment consisted of 1725 lb. of quebracho, 2700 lb. of caustic soda, and 3313 lb. of Impermex to a mud system of about 800 bbl. The resulting mud tested 2.8 cc. water loss with a pH of 12.3 but the viscosity of the mud, because of the extremely high content of bentonite and inert solids, was very high. The mud could have been diluted with water from 20 to 40 percent, thus reducing both solids and gel content and allowing the required chemical treatment to be performed with greater ease and less material. As an acute caving condition existed in the well it was deemed inadvisable to change the weight or viscosity of the drilling fluid so radically during any phase of treatment. The mud was therefore treated carefully by additions of quebracho, caustic soda and the organic colloidal material until it had a water loss of 2.0 cc. and a pH of 12.3.

This treated mud with its low water loss began cleaning up the hole immediately and the shale content of samples returned to normal the second day after treatment. Trips were easily made with only 5 ft. of caving on bottom after the second trip and no cavings after the third trip. Previously, 200 to 300 ft. of cavings had been common and trips that had taken from 8 to 10 hr. were reduced to 5 or 6 hr.

Similar results have been obtained in caving holes in California by the use of extremely low-water loss mud fluids and at the time of writing one well is being drilled ahead after a period when no hole could be made because it required a change of bit after drilling out the cavings that had sloughed into the well during the round trip.

☆ ☆ ☆

FROM WASHINGTON

New Order an Aid to Secondary Recovery

To facilitate the program for secondary recovery of crude oil throughout the country, a program of tremendous importance in view of the continued depletion of known oil reserves, the Petroleum Administration for War has issued supplementary order No. 6 to petroleum administrative order No. 11, which will permit oil operators to acquire and use materials in secondary recovery operations without regard to restrictions otherwise imposed by PAO No. 11.

Commenting on the amended order, Ralph K. Davies, deputy petroleum administrator, stressed the growing importance of secondary recovery operations as a source of crude oil to meet the steadily increasing war requirements.

"Secondary recovery means getting more of the oil which we know is in the ground," Davies said.

"It is especially important, in view of the disappointing new discovery records of recent years, that we exert our efforts and ingenuity to increase secondary recovery production at this time. The Petroleum Administration hopes that operators will take early advantage of the authorization included in this supplementary order to inaugurate an unprecedented number of secondary recovery projects.

"Secondary recovery operations are considerably more costly than primary production operations and it is realized that the existing crude oil price level is not favorable toward the initiation or conduct of these operations. This is one of the important reasons which have led the Petroleum Administration to recommend a general upward adjustment in the crude oil price ceiling."

Under the terms of the supplementary order, secondary recovery operations involve the injection of air, gas or water into the producing formation for the purpose of increasing or sustaining production therefrom, and include the drilling of production or injection wells. Pressure maintenance, high-pressure cycling, and salt water disposal are specifically excluded from the definition of secondary recovery.

The authorization under the amended order extends only to an operator who conducts the specific injection program, or who contributes money, property, or service as a participant in a specific secondary recovery program. The authorization for drilling production wells extends only to such operations conducted within a radius of 2000 ft. of any air or gas injection well, or within 1000 ft. of any water injection well.

Tubular Goods Depots Established

Location of 12 oil-country tubular goods depots to be established to meet emergency needs of wildcat operators has been announced by Deputy Petroleum Administrator for War Ralph K. Davies. The depots are expected to be in operation some time in August.

Towns in or near which the depots will be situated and the quantity of tubular goods to be kept on hand are: Chase, Kansas, 800 tons; Mt. Pleasant, Michigan, 400 tons; Grayville, Illinois, 500; Seminole, Oklahoma, 500; Houston, Texas, 1300; Corpus Christi, Texas, 800; Odessa, Texas, 700; Shreveport, Louisiana, 700; Wichita Falls, Texas, 600; Cut Bank, Montana, 400; Casper, Wyoming, 600, and Los Angeles, California, 2700 tons.

Plans to establish the emergency tubular-goods depots were announced by Administrator Harold L. Ickes recently. Object of the depots is to encourage wildcat drilling operations by meeting the need for minimum stocks of materials that will be available immediately when required for wildcat and emergency purposes. The Administrator estimated that at least 4500 wildcat wells should be drilled this year.

LIBERTY

versus

Compulsion

We are engaged in the greatest war in history—to determine whether our nation and other nations founded on liberty and the dignity of the individual shall endure.

The struggle is between two totally opposite ideologies. One is based on brute force, the top gang keeping its power by compulsion. The other is based on logic and persuasion, the leaders obtaining office by vote and remaining there only by the consent of the governed. Under regimentation creative research congeals and the masses produce and fight as sullen slaves. Under democracy creative research is stimulated and mass production multiplies. Soldiers go to battle with unbeatable spirit because of the determination of free men to maintain that priceless gift which they have won after ages of fighting and which they will never give up . . . the gift of liberty.

When the war is won and we return to peace time pursuits there will still be a big job to do in rehabilitating a broken world. People everywhere will look to America. Our business men and leaders will have a great responsibility and a great opportunity. In keeping with this thought the Mission Manufacturing Company is planning many advancements and improvements in its products for the benefit of oil men who will be busy to a degree never before experienced. In the meantime war comes first.

Buy Bonds for Victory

and to insure a strong and stable United States when the war is over.

MISSION MANUFACTURING CO.

HUMBLE ROAD HOUSTON, TEXAS

MANUFACTURERS OF:

Mission Slush Pump Valves—Mission Slush Pump Pistons—Mission Piston Rods—Mission Gland Packings—Mission Rotary Slips—Mission Swabs—Mission Plug Valves

OIL WELL IMPROVEMENTS CO.

Pioneer creator and manufacturer of drilling and producing equipment, has been in the

FIRST LINE
of the Oil Industry's
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And while most of our production facilities are devoted to vital production for our fighting Navy, we will continue to furnish Orbit Valves to the Oil Industry to the limit of our ability.

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TULSA, OKLAHOMA

Running Tour

WITH MEN IN THE INDUSTRY

WIRT FRANKLIN, Ardmore, Oklahoma, has been appointed special field assistant attached to the deputy petroleum administrator's office by Administrator Harold L. Ickes. The job will be to encourage exploration in search of new reserves and to stimulate secondary recovery operations to increase output of petroleum from producing wells. Before this appointment Franklin was district director of production and director in charge of District 2, the Middle West, in the PAW.

D. T. O'CONNOR has become associated with Edward L. Carter, New York City, export manager for the Shaffer Tool Works, W. C. Norris, Manufacturer, Inc., Wheatley Brothers Pump and Valve Manufacturers, Tom Wheatley Company, and the American Machinery Corporation. O'Connor was formerly connected with the Lago Petroleum Corporation, Maracaibo, Venezuela, with the Bahrein Petroleum Company, Bahrein Island, and more recently with the Trinidad Leaseholds, Ltd., Trinidad, British West Indies.

D. T. O'CONNOR

EDWARD MICHAEL SKEEHAN, JR., 26, aviation machinist mate, second class, was killed June 26 in an airplane crash somewhere off the Atlantic coast, according to word received by his father, E. M. SKEEHAN, vice-president and treasurer, Barnsdall Oil Company, Tulsa, Oklahoma. When young Skeehan entered naval service in April, 1942, he was employed by the Barnsdall Oil Company of California.

CHARLES H. RANKIN has accepted a position as engineer for the Loco Hills Pressure Maintenance Association, Artesia, New Mexico. Rankin was formerly with Continental Oil Company at Electra, Texas.

DR. HUGH M. HUFFMAN, formerly of the California Institute of Technology at Pasadena, has been named to direct operations of a new laboratory at the U. S. Bureau of Mines Petroleum Experiment Station in Bartlesville, Oklahoma. A native of California, Dr. Huffman was educated at Stanford University, receiving a Ph.D. in 1928. The initial project the new director will undertake will be a study of the possibilities of direct conversion of butane to butadiene as an aid to the economic manufacture of synthetic rubber. The general function of the laboratory will be the determination of the thermodynamic properties of hydrocarbons and their derivatives.

EDWARD B. REESER, president of the Barnsdall Oil Company, will retire August 1 after 35 years with the firm. He began as an office boy for the late T. N. Barnsdall, founder of the company, which was organized in Pittsburgh, Pennsylvania, and advanced steadily to the highest post in the organization. Reeser, an outstanding figure in the oil industry, said his company had a retirement plan for all employees and he had reached the age of 70 years.

EDWARD B. REESER

JAMES A. DUNN, vice-president and secretary of Barnsdall, will succeed Reeser as president. He will maintain offices in New York, the headquarters of the organization, which is active in oil production in Oklahoma, Kansas, Texas, Arkansas, and California. D. R. SNOW will continue as vice-president and general manager with offices at Tulsa, Oklahoma, and will be in general charge of the company's operations in the Mid-Continent area. W. C. WHALEY, vice-president and general manager in charge of California operations, will remain in that position with headquarters in Los Angeles. FRANK BRAMAN, with offices in New York, will be advanced from assistant secretary of the firm to secretary.

PAUL C. COFFIN, 46, member of the board and vice-president in charge of operations for the Shamrock Oil and Gas Corporation, Amarillo, Texas, died June 22 at his home. Coffin had been associated with Lone Star Gas Company from the time he was graduated from Texas A. and M. in 1921 until he resigned to go with Shamrock in 1939.

JOE B. RAYFIELD, superintendent of the Lone Star Producing Company's gasoline plant at Gordon, Texas, has been placed in charge of the firm's new central fractionating plant at Ranger, according to HARRY WHEELDON, general superintendent. Rayfield will be succeeded at Gordon by J. F. FRANCIS, superintendent of the Pueblo gasoline plant, who in turn will be replaced by LATTIE M. COWLEY, who had charge of the gasoline plant No. 101 at Ranger until its conversion into a central fractionating plant. The new plant processes natural gasoline into special products used in making airplane fuel.

PAUL M. RAIGORODSKY, assistant director of the Natural Gasoline Division, PAW, has resigned to return to private industry. He has been on leave of absence as vice-president and general manager of Petroleum Engineering, Inc., and the Glen Rose Gasoline Company, both with offices in Tulsa, Oklahoma, and Houston, Texas. A native of Russia Raigorodsky came to the United States in 1921. He studied in Russia and Czechoslovakia and was graduated from the University of Texas in 1924.

HOMER F. WILCOX, discoverer of the Wilcox sand and organizer and president of the H. F. Wilcox Oil and Gas Company, announced his resignation and retirement from the firm. He will be succeeded as president by FRANK H. DUNN, executive vice-president and aid to Wilcox for 24 years. EDWARD J. O'HERRON, wealthy Charlotte, North Carolina, druggist, is the new chairman of the board of directors.

The executive committee is made up of DUNN, MELVIN P. APPLEBY, treasurer and executive vice-president, and HORACE B. CLAY, general counsel.

FRANKLYN WALTMAN has been appointed director of public relations of the Sun Oil Company, Philadelphia, Pennsylvania, it has been announced by J. HOWARD PEW, president. Waltman succeeds the late JUDSON C. WELLIVER, who died recently after serving the firm 12 years.

FRANK LINGENFELTER, 51, well-known drilling operator, died recently at Mattoon, Illinois. At one time Lingenfelter headed the producing department of Ohio Oil Company in Kansas. He was associated with Burrell Williams, another former Mid-Continent contractor.

FOSTER B. PARRIOTT, director of the Sunray Oil Corporation of Tulsa, Oklahoma, since 1937, has been elected chairman of the board. Head of the Transcontinent Oil Company until it merged with Ohio Oil Company in 1930, he was then chief of the Leader Oil Company whose assets he sold to Carter Oil Company last year. C. H. WRIGHT is president of Sunray.

GRAHAM ROHRER, who has been connected with The Baldwin Locomotive Works, Philadelphia, Pennsylvania, for the last eight years, has resigned his position as advertising supervisor. He began his new duties as advertising and sales promotion manager of Baldwin-Hill Company, Trenton, New Jersey, on July 12.

G. J. NEUNER, Kansas City, Missouri, has announced his resignation as vice-president of the Panhandle Eastern Pipe Line Company after a connection of 12 years. Neuner expects to resume his practice of law, specializing in legal matters pertaining to the oil, gas, and utility industries, a field of activity in which he has been engaged since he began his career in 1916. Shortly after leaving school he joined Cities Service Company, was later assistant general counsel for the Barnsdall Oil Company before he became counsel for Panhandle Eastern Pipe Line Company.

Both Scrappers

Those gnarled hands can still turn in a full day's work—and that oil-encrusted Ludlow can still valve oil with the best of them. All either one needed was the opportunity that war provided. Why not check up on your retired valves? You may well find that a few replacement parts will fit them for continued service—particularly Ludlows.

Now that you think of it—hasn't this more-than-average service always been a Ludlow characteristic? For these extended-service valves, Ludlow will aid in supplying the same enduring replacement parts. Check up on your priority and send in your order.

THE LUDLOW VALVE MFG. CO., INC.
TROY, NEW YORK

V-15

Construction Features: Self-releasing 30° angle wedges and free-floating gates, self-adjusting to seats, afford smooth, trouble-free performance, long service. Rings are cleaned throughout stroke action. Gates are wedge-locked directly opposite ports and completely unwedged before raising. Ample tolerances provide easy action. Simple construction permits easy replacement of parts.

LUDLOW VALVES SINCE 1866

MACHINERY and EQUIPMENT

Outdoor Photoelectric Relay

A GENERAL-PURPOSE photoelectric relay for outdoor use has been announced by the Electronic Control Section of the General Electric

Company. Designated as the Type CR7505-K108, it is for applications requiring rapid and accurate counting, controlling, sorting, or limiting operations. Its contacts control 2 amp. at 115 volts, 25- to 60-cycles, a.c., or 0.5 amp. at 115 volts, d.c.

In addition to a Type GL-930 phototube, the new relay contains a Type GE-117P7GT pliotron tube. This amplifier tube is outstanding in two respects—its filament operates on full line voltage, eliminating the need for a filament transformer; and it incorporates a diode rectifier that functions when a-c. power supply is used.

The relay's weatherproof case is equipped with a sun shield and a large, directional lens system to minimize the effect of slanting sun rays. In addition, the lens system increases the relay's sensitivity.

The relay can be mounted in any position and can be adjusted under actual operating conditions, without removing the cover. The chassis can be removed easily from the case for inspection or servicing or, if desired, for mounting with other apparatus in a combination enclosure.

Bulletin GEA-1755E gives details on this and other photoelectric relays.

Thor Plastic Drill

FOURTEEN percent lighter in weight, but packing more power per pound under its "Thorite" plastic armor, a new Thor ¼-in. capacity electric drill was announced recently by Independent Tool Company, Chicago, Illinois.

Thor "armored in plastic" construction of the new drill, featuring double protection of the operating parts within an inner metal skeleton frame that is covered by entirely separate plastic housings, provides fast drilling because it is lighter and easier to handle, the manufacturer states.

The new Thor drill weigh only 3¼ lb., measure $8\frac{3}{16}$ in. in length, and are available in three speeds, the Thor U14K at 2500 r.p.m., the Thor U13K at 3750 r.p.m., and the Thor U12K at 5000 r.p.m.

Pipe Line Filters

THE use of steel pipe lines for the transportation of crude oil and refined petroleum products dates back many years, but wartime needs for an uninterrupted flow of these materials has given great impetus to pipe-line construction. Consequently, interest has been stimulated in the utilization of equipment that will permit the pipe line to function at its maximum efficiency. This means the maintenance of peak carrying capacity with minimum time out for cleaning.

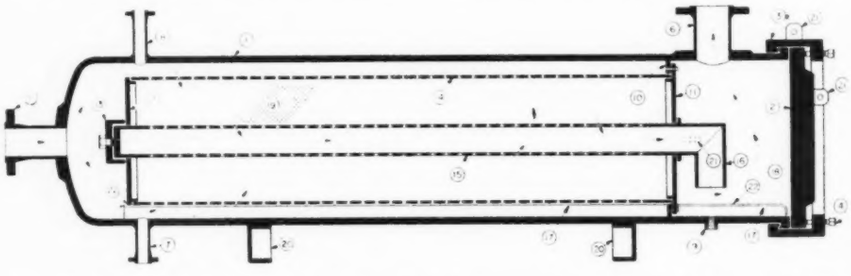
Internal corrosion of pipe lines results in formation of solids and semi-solids that would normally be pumped through the pipe line. The physical structure of these solids varies from minute grains of silt to dirt particles of considerable size built up by accumulation while passing through the line. Obviously, this foreign material in the solid form causes difficulties and damage to valve seats, pumps, and meters throughout the system, unless some provision is made to collect and remove it from the line.

Alco pipe line filters offer improvements in three essential features, according to the manufacturer:

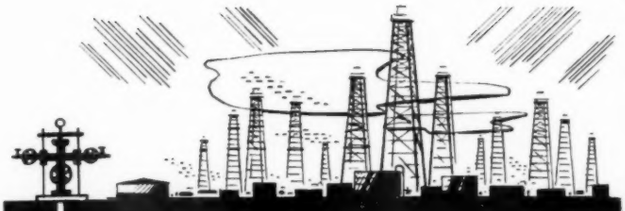
1. Increased filtering capacity,
2. Decreased time out for recharge of filter,
3. Ease of dismantling and assembling.

Increased filtering capacity is achieved by (1) A reduction in the velocity of the liquid upon its entrance into the filter. As shown by the accompanying cross-sectional view, the shell space at the incoming end and around the perforated basket screen provides ample area for the heavier solids to deposit out at the bottom of the shell, before contacting the filtering media in the basket. (2) By directing the flow through the filter from the outside of the basket to the efflux pipe in the center, initial contact with the filtering media is made where its area is the maximum. This design permits the filter to be kept on stream at full rated discharge capacity for a longer time.

Frequent recharging of any pipe line filter is, of course, a necessity. Consequently, any feature tending to lessen the time "off stream" is very desirable. The construction of the Alco filter permits an absolute minimum "off stream" period, it is stated. The bolts in the two-piece Alco clamp ring for attaching the cover plate can be quickly backed out just far enough for the clamp to clear the beveled groove in the shell flange. The bolts remain in the clamp ring—none is lost and no time is spent searching for mislaid bolts. The clamp ring and cover plate are removed, tap bolts are backed out of basket retaining flange, and the complete basket can then be withdrawn.



1. Welded steel shell. 2. Cover. 3. Alco clamp ring. 4. Compression bolting. 5. Inlet nozzle. 6. Outlet nozzle. 7. Drain nozzle. 8. Vent nozzle. 9. Drain coupling. 10. Basket retaining flange. 11. Basket front end plate. 12. Basket rear end plate. 13. Yoke and tap bolt. 14. Perforated basket screen. 15. Perforated efflux pipe. 16. Efflux pipe outlet elbow. 17. Guide strips. 18. Outlet channel. 19. Filtering material. 20. Support saddles. 21. Lifting lugs. 22. Non-ferrous facings.



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Producing wells can be ruined with mud and water. When your well needs servicing, call Otis . . . they can run and pull tubing, packers or drill pipe under pressure with no danger to future production.

Ten years' experience on 6,102 wells is your assurance of a job well done.

Trained Otis Service Crews are available in all major high pressure areas. Don't risk damaging your well with mud. The cost of Otis service is negligible compared to such loss.

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DALLAS, TEXAS

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Export Office: 74 Trinity Place, New York City

Young

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Save Building

40 MILE PIPE LINE!

Faced with building a 40-mile pipe line for water to cool six 800 H.P. gas-engine compressor units and auxiliary engines, the El Paso Natural Gas Company decided on a test installation of YOUNG-HAPPY Engine Jacket Water Coolers. So satisfactory was the test that eleven YOUNG-HAPPY Coolers, each consisting of two large vertical radiator sections and a specially designed, highly efficient, variable pitch fan have been installed. Tests were run and five YOUNG-HAPPY Gas Coolers installed for cooling the gas after compression. YOUNG-HAPPY engineered cooling units fit ALL the requirements of the job. They save war-vital steel and cut power consumption costs. Let YOUNG solve *your* cooling problems.

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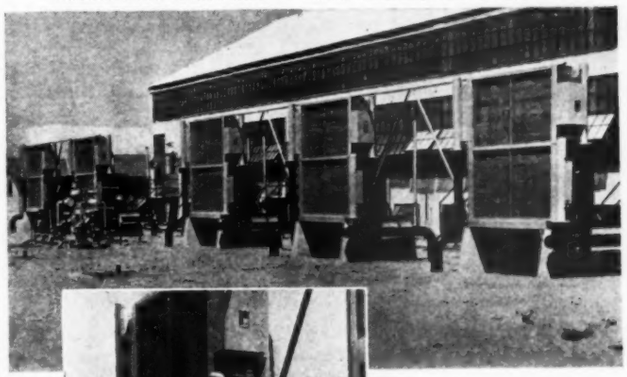
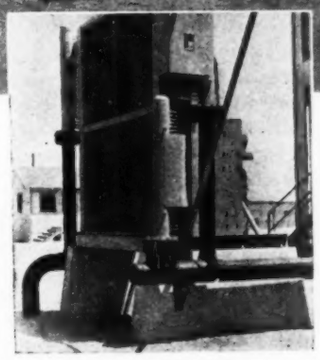
Mid-Continent Distributor — The Happy Co., Tulsa, Okla.
Pacific Coast Distributor — A. R. Flournoy Co., Bell, Calif.





Five YOUNG-HAPPY single phase gas coolers.

*

Close-up of one of the above units.

Young

Product of Young Engineering and Manufacturing SERVICE — Specializing in Heat Transfer Products

HEAT TRANSFER PRODUCTS

OIL COOLERS • GAS, GASOLINE, DIESEL ENGINE COOLING RADIATORS • INTERCOOLERS • HEAT EXCHANGERS • ENGINE JACKET WATER COOLERS • UNIT HEATERS • CONVECTORS • CONDENSORS • EVAPORATORS • AIR CONDITIONING UNITS • HEATING COILS • COOLING COILS

Proportioning Equipment

D. W. HAERING AND COMPANY, INC., 205 West Wacker Drive, Chicago, Illinois, announce the publication of a new 8-page bulletin describing the latest developments in proportioning and sampling equipment. Construction, operation, and application of the improved Nelson Chemical Proportioning Pump are discussed. This is the synchronized drive chemical pump that has gained wide favor in the solution of proportioning problems in the petroleum and water conditioning industries. This latest design in proportioning pumps has widened the scope of application to all industries where reciprocating pumps are used in processes requiring proportioning. Dependent only upon the pressure surges developed by a master reciprocating pump, this pump is otherwise entirely self-contained. Complete dimensions, capacities, and operating data, together with a thorough discussion of the Nelson valve and packing construction are presented.

The fluid piston principle, basis of the popular Model "B" feeder and all Haering proportioning and sampling machines is explained and thoroughly discussed with reference to design, construction, and operation of these machines. Haering feeders have received wide acceptance for proportioning chemicals in a variety of industries, including the fields of corrective water treatment, chemical, petroleum, and general processing. The latest improvements in the design of these machines are discussed, pointing to increased operating efficiencies and convenience.

THAT'S WHAT THEY'RE BUILT FOR!

AMERICAN FULL ROLLER BEARINGS are made to meet exacting bearing requirements demanding the utmost in strength, durability and smooth, continuous performance under gruelling and abusive operating conditions. AMERICAN FULL ROLLER BEARINGS are carefully engineered, service-proven, time-tested. They are specially designed for extra heavy duty service and guaranteed to give flawless, trouble-free performance under the most severe strains and stresses encountered in the operation of modern heavy industrial machinery and equipment. Because they are built to outlast the equipment itself, few AMERICANS have ever failed in service.

Consult AMERICAN engineers on your next full-roller application.

AMERICAN ROLLER BEARING COMPANY
PITTSBURGH PENNSYLVANIA
Pacific Coast Office: 1718 S. Flower Street, Los Angeles, California

AMERICAN HEAVY-DUTY ROLLER BEARINGS

Register Extension for Rotocycle Meters

THE Pittsburgh Equitable Meter Company, Pittsburgh, Pennsylvania, manufacturers of Rotocycle bulk plant, tank truck, and pipe-line meters, has announced the availability of an extension drive for registers used on any of its meters. The purpose of this extension is to permit installing the meter proper beneath the platform of loading racks, in pits or underground so that all that intrudes into the working area is the relatively compact register. This makes an attractive and clean installation.

Rotocycle Meter, Model B-5, fitted with Master Meter Duplicator and extension drive.

The register extension is made of heavy pipe fitted with internal bearings for the support of the register driveshaft. To it may be applied any of this company's complete line of registers including straight reading, straight reading reset, vertical dial and Master Meter Duplicator. It can be supplied in any length up to a maximum of 5 ft.

Transcord Breaker

A PATENT has recently been granted on its Transcord Breaker, used in constructing conveyor belting, to The B. F. Goodrich Company.

Principal feature of the Transcord Breaker is that the breaker cords are placed across the belt width, rather than parallel with the cords of the belt itself. This provides greater resistance to cutting action from materials striking the belt, which most often move faster or slower than the belt itself.

The Transcord Breaker also provides much greater adhesion between cover and carcass than the regular breaker construction. Tests of both types on conveyors in heavy-duty service have proved this definitely, it is stated.

Huffman Appointed Kobe Production Manager

Samuel A. Huffman has been appointed plant manager of Kobe, Incorporated, Huntington Park, California. According to C. M. Rader,

SAMUEL A. HUFFMAN

assistant general manager, Huffman will be in complete charge of hydraulic manufacturing.

Huffman, graduate of the University of Cincinnati, is a mechanical engineer whose first position was as a machine designer of automatic machinery for the U. S. Playing Card Company of Cincinnati. In 1935 he joined the Miller Printing Company of Pittsburgh. Later, he became plant manager for this company. Subsequently, Huffman became associated with the Arms Franklin Corporation.

W. B. Gillies Passes Away

William B. Gillies, vice-president in charge of operations of The Youngstown Sheet and Tube Company and president of the Youngstown, Ohio,

WILLIAM B. GILLIES

Chamber of Commerce, died June 20, after a heart attack.

Gillies was born in Chicago, Illinois, October 6, 1883. He attended Armour Institute, Chicago, and graduated in mechanical engineering from Cornell University in 1904.

Gillies began his career in the steel industry immediately after his graduation from college, as foreman for Illinois Steel Company.

Named on Rotary Board

J. B. Reilly, president of Fluid Packed Pump Company, was recently elected a board member of Rotary International at the club's annual convention held in St. Louis, Missouri.

Reilly, a pioneer oil man, was reared in the California fields and has been in the oil tool business all his life. He has held many responsible local and district positions in Rotary, and his elevation to International Board member climaxes many years of untiring effort in furthering the club's interests.

Correction

On page 236, July 1st issue, "Pumps in the Chemical Industry" by W. W. Mellen and A. P. Smith, the footnote should have read: "Presented before American Institute of Chemical Engineers, Boston, Massachusetts, meeting, May 11-13, 1942, and published in *Transactions*, Vol. 38, No. 4, 1942."

HANLON-WATERS INC. H-W

STANDARD FOR PERFORMANCE

24" - 125 LB. FLANGED END

H-W Type 1586

BUTTERFLY VALVE

Multiple spring loaded diaphragm actuated top works with powerful leverage attachment to valve shaft. Travel Indicator with full 90° travel of inner valve. Extra heavy construction of internal valve flapper and shaft to withstand high pressure differentials across valve. Shaft supported on ball bearings to minimize friction. Ball bearings enclosed in grease packed journals with fittings for pressure lubrication.

ASK THE MEN WHO OPERATE THEM!

Information on all HANLON-WATERS Equipment available at representative nearest you

HANLON-WATERS, INC.

TULSA, OKLAHOMA

New York, Chicago, Pittsburgh, Philadelphia, St. Louis, Denver, Los Angeles Shreveport, La. Fort Worth, Houston, Corpus Christi and Odessa, Texas.

Gold Star to Wickwire Spencer

Wickwire Spencer Steel Company has received its first gold star for its Palmer, Massachusetts, wire rope plant from the United States Maritime Commission, E. C. Bowers, president, announces. This plant last October received from the commission the Maritime "M" award and at that time "M" badges were given to the plant's 1500 employees at ceremonies attended by Governor Leverett Saltonstall of Massachusetts.

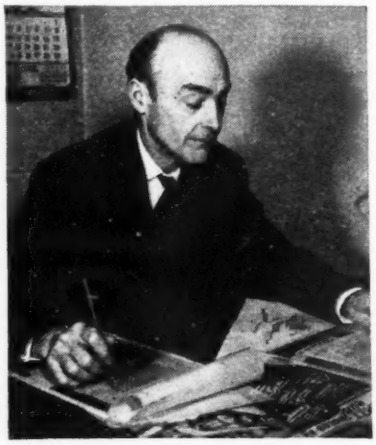
In recognition of continued outstanding production achievement Admiral H. L. Vickery notified Bowers that the company should add a gold star to the Maritime "M" burgee and that the "M" badge would be awarded to 325 additional employees.

Wire rope manufactured at Palmer is used extensively in the rigging of Liberty ships as well as for other naval and hundreds of industrial purposes.

York Is Clark Advertising Manager

Clark Bros. Co., Inc., Olean, New York, recently announced the appointment of John L. York as advertising manager.

York has had many years' experience in the advertising field. He studied art at the Art Institute of Chicago and worked with one of the leading illustra-



JOHN L. YORK

tors of the country for a number of years acquiring a considerable knowledge of advertising layout, illustration, and copy. After this experience, he served with the Waltham Watch Company both in this country and in England and later as advertising manager of the Watson Company of Attleboro, Massachusetts, and of the Metro Stations, Inc., now part of the Socony-Vacuum Oil Company. He also served for short periods with advertising agencies.

Hilliard in Charge of BJ Export Office

B. E. (Ben) Hilliard has been placed in charge of the New York export office of the Oil Tool Division of Byron Jackson Company, at 420 Lexington Avenue, New York City. Hilliard formerly was in charge of the West Texas and Kansas territories for BJ oil tools.

RUBBER PRODUCTS

AVAILABLE IN STOCK

V-BELTS

MULTIPLE DRIVE BELTS — MATCHED SETS

PARTIAL LIST OF SIZES

Belt Sizes A WIDTH	Belt Sizes B WIDTH	Belt Sizes C WIDTH	Belt Sizes D WIDTH
A-26	B-42	C-51	D-120
A-31	B-46	C-60	D-128
A-35	B-51	C-68	D-144
A-38	B-55	C-75	D-158
A-42	B-60	C-81	D-162
A-46	B-68	C-85	D-173
A-51	B-75	C-90	D-180
A-60	B-81	C-96	D-195
A-68	B-85	C-105	D-210
A-75	B-90	C-112	D-240
A-80	B-97	C-120	D-270
A-85	B-105	C-128	D-300
A-90	B-112	C-144	D-330
A-96	B-120	C-158	D-360
A-105	B-128	C-162	E WIDTH
A-112	B-144	C-173	E-180
A-120	B-158	C-180	E-195
A-128	B-173	C-195	E-210
	B-180	C-210	E-240
	B-195	C-240	E-270
	B-210	C-270	E-300
	B-240	C-300	E-330
	B-270	C-330	E-360
	B-300	C-360	

IMMEDIATE DELIVERY

RUBBER BELTING

HEAVY DUTY — SILVER DUCK — SQUARE EDGE

A.P.I. SPECIFICATIONS

Furnished in All Required Lengths

Width Ply	Width Ply
8" x 6	14" x 6
10" x 6	16" x 6
12" x 6	18" x 6

(Other Sizes Available)

RUBBER HOSE

All Types and Sizes for Use on

LOADING RACK, OXY-ACETYLENE WELDING, COMPRESSORS, STEAM, OIL, SUCTION, WATER, FIRE, PAINT, ETC.

FORMATION TESTER PACKER ELEMENTS see page 576 Composite Catalogue

Furnish Details of Your Requirements . . . Prompt Quotations . . . Immediate Deliveries

CARLYLE RUBBER CO., INC.

62-64 PARK PLACE • NEW YORK 7, N. Y.

PIPE WIPER

The most useful fitting on the rig. Strips pipe clean of mud. Saves wash water. Try one.

PATTERSON BALLAGH CORPORATION

Los Angeles Houston New York City

Byron Jackson Changes

The Oil Tool Division of Byron Jackson Company announces the appointment of O. W. Morgan, Jr., as sales manager. "Ox" Morgan, as he is known to his many friends in the petroleum in-

O. W. MORGAN, JR.

dustry, has served the company in several of its offices. He will make his headquarters at Los Angeles, California.

Garth F. Nicolson has been promoted to the combined position of works manager and chief engineer of the Oil Tool Division after many years' engineering and research work.

Terminating 11 years' service with Byron Jackson Company, Frank

FRANK CHAMPION

Champion has resigned as vice-president and general manager of the Oil Tool Division, but will serve as a director of the company. Champion now is associated with Glenn H. McCarthy as general manager of drilling and production operations, and will maintain his offices and residence at Houston, Texas.

Dresser Appointments

H. N. Mallon, president of Dresser Manufacturing Company, has announced the election of Norman Chandler, of Los Angeles, as a member of the company's board of directors, and of R. E. Reimer, Bradford, Pennsylvania, as secretary-treasurer.

Chandler is president and general manager of the Los Angeles Times and secretary of the American Newspaper Publishers Association. He is also a director of Pacific Pump Works, of Huntington Park, California, one of Dresser's subsidiaries.

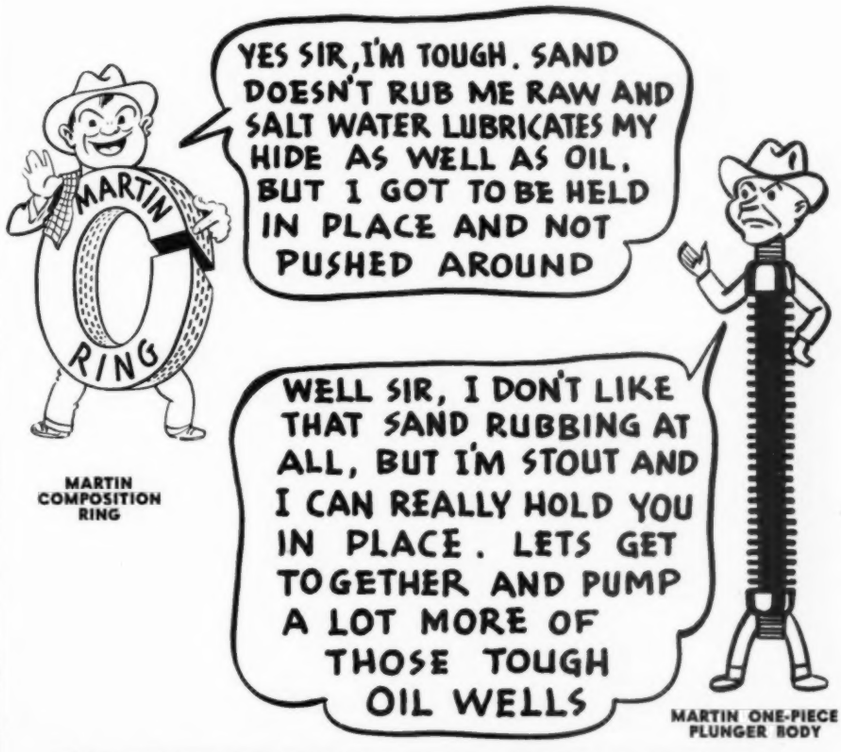
Reimer has been with the company since January, 1929, and has been treasurer since May, 1932. His election as secretary fills a vacancy caused by the death of Merrill N. Davis.

Brown Appointments

Appointment of George M. Muschamp and Paul L. Goldstrohm as vice-presidents of the Brown Instrument Company, a subsidiary of Minneapolis-Honeywell Regulator Company, was announced recently.

Muschamp will be vice-president in charge of engineering and Goldstrohm will be vice-president in charge of production. Both posts are newly created.

It Takes TEAM WORK to get that Pumping Job done!


YES SIR, I'M TOUGH. SAND DOESN'T RUB ME RAW AND SALT WATER LUBRICATES MY HIDE AS WELL AS OIL, BUT I GOT TO BE HELD IN PLACE AND NOT PUSHED AROUND
MARTIN RING
WELL SIR, I DON'T LIKE THAT SAND RUBBING AT ALL, BUT I'M STOUT AND I CAN REALLY HOLD YOU IN PLACE. LETS GET TOGETHER AND PUMP A LOT MORE OF THOSE TOUGH OIL WELLS

MARTIN COMPOSITION RING

MARTIN ONE-PIECE PLUNGER BODY

MARTIN PLUNGERS

are made to fit all sizes of working barrels and all sizes and makes of rod pumps.

Write for Illustrated Catalog or See Composite Catalog

JOHN N. MARTIN
Manufacturer
11 W. Brady St. Tulsa, Okla.

Field Representatives

Tom Hulett, El Dorado, Ark.
C. J. Baeten, Wichita, Kansas
Lynn C. Holloway, Houston, Texas
Hugh Robinson, Blackwell, Okla.
F. M. Wilson, Wichita Falls, Texas
J. Walter Wade, Olney, Illinois
E. C. Dilgarde, Casper, Wyoming

Los Angeles Nomads To Hold Annual Party

The fourth annual "Wing Ding" of the Los Angeles Chapter of Nomads will be held at the Riviera Country Club near Los Angeles during the afternoon and evening of Friday, July 23. As heretofore, the event will consist of a golf tournament, games of skill, dinner, and a floor show.

Nomads and guests competing in the golf tournament will tee off between 12 noon and 1 o'clock. Prizes for this event will be awarded at the dinner hour.

The games of skill will be played for stage money between 5 and 8 p.m. The dinner hour will be an event in itself with the awarding of golf prizes, a door prize, and the auctioning of the game prizes.

The "Wing Ding" is being handled by a committee consisting of the following: Fred Tyler, chairman; Ernie Fowks, program manager; George Trembley, golf manager; Elmer Smith, in charge of prizes and finance; J. V. Robinson, in charge of games of skill, and Wallace Sawdon, in charge of entertainment.

BUILT WITH "GUTS" FOR EXTRA HEAVY DUTY
AMERICAN HEAVY DUTY ROLLER BEARINGS have built into them the vital extra capacity for continuous 24-hour-a-day performance under the most gruelling service conditions possible. Brutally strong . . . simply constructed . . . precise . . . AMERICANS operate quietly, smoothly, in the heaviest equipment under the most terrific strains and impacts. Longer, safer, lower-cost, trouble-free service is assured when AMERICAN HEAVY DUTY ROLLER BEARINGS are on the job. That's why most major manufacturers and designers of heavy industrial machinery and oil country equipment specify AMERICANS.
In your next heavy-duty installation, ride the load on AMERICANS. Our engineers will welcome your roller bearing problems. Write today.
AMERICAN ROLLER BEARING CO.
Pittsburgh Pennsylvania
Pacific Coast Office:
1718 S. Flower Street Los Angeles, Calif.
HEAVY DUTY
AMERICAN
HEAVY-DUTY
ROLLER BEARINGS

Mauthe Promoted by Youngstown Sheet & Tube

Appointment of J. L. "Pete" Mauthe as vice-president in charge of operations of The Youngstown Sheet and Tube Company to succeed the late William B. Gillies has been announced by President Frank Purnell. The appointment became effective July 1.

In the new position, Mauthe will have charge of operations of the company's Youngstown and Chicago district manufacturing properties as well as supervising all its mining properties. A successor as general superintendent of the company's Youngstown district plants, including Campbell, Brier Hill, and Hubbard, will be announced later.

J. L. MAUTHE

Mauthe's promotion came after 31 years in the iron and steel industry, eight of those years with The Youngstown Sheet and Tube Company and many others with U. S. Steel Corporation subsidiaries in various places.

Security Wins Gold Star

Recently the United States Maritime Commission honored the Security Engineering Company, Inc., Whittier, California, by presenting a gold star for continued meritorious production of vital war materials. The gold star award was preceded on October 15, last year, by the Maritime M Pennant.

Concluding the program, W. E. Sievers, executive vice-president of Security, presented a scroll containing 400 signatures to O. D. MacLean, assistant director of production of the U. S. Maritime Commission. The scroll was individually signed by Security officers and employees and pledged continuous effort in filling U.S.M.C. contracts.

Jones & Brooks to Dallas

Jones and Brooks, pipe line contractors, have moved their headquarters from Oklahoma City, Oklahoma, to Dallas, Texas. Their new offices are at 2508 Mercantile Bank Building. Partners are Ray Jones and Bert Brooks.

TRADE LITERATURE

What to Write For

THE STORY OF MAXIM WASTE HEAT UNITS is told in Bulletin WH-100 available through the Maxim Silencer Company, 99 Homestead Avenue, Hartford, Connecticut. These waste heat units combine silencing with spark arresting and utilization of waste exhaust heat to produce steam or hot water.

ENGINES THAT FEED THE "BIG INCH" are described in Bulletins 822 and 1136, which can be obtained by writing to Waukesha Motor Company, Waukesha, Wisconsin. Waukesha engines for pumps are covered in these booklets.

"PIPING POINTERS" is a bulletin published by Crane Company for maintenance men with the idea of helping prevent delays on piping jobs. It can be obtained through any Crane representative or by request to Crane Company, 836 South Michigan Avenue, Chicago, Illinois. Practical pointers of wartime piping, short-cuts in maintenance, and safe hints on substitute materials are contained in Bulletin 6.

JOHN N. MARTIN, MANUFACTURER, 11 West Brady Street, Tulsa, Oklahoma, will send an illustrated catalog upon request, describing the Martin composition ring and one-piece plunger body.

A COPY OF "Practical Information on the Use and Care of Wire Rope" will be sent upon request by A. Leschen and Sons Rope Company, 5909 Kennerly Avenue, St. Louis, Missouri. The booklet discusses selection of wire rope, its proper installation, and sound maintenance procedure. It also carries material about the Hercules rope and its construction.

"IDEAS TO HELP YOU KEEP YOUR PRESENT EXCAVATORS WORKING AND DOING MORE TO WIN THE WAR" is a new booklet free to owners and operators of shovels, cranes, and draglines. It may be procured from a Bucyrus-Erie distributor or by writing direct to Bucyrus-Erie Company, Publicity Department, South Milwaukee, Wisconsin. The 32-page booklet contains no advertising material but gives more than 100 tips on the proper operation and care of excavators.

A 24-PAGE BROCHURE on the Buckeye clipper shovel will be sent upon request by the Buckeye Traction Ditcher Company, Findlay, Ohio. The "Mevac" vacuum power control and exclusive features resulting from it are the subject of the well-illustrated booklet. Clipper convertible shovels, cranes, trench hoes, draglines, and pile-drivers are shown.

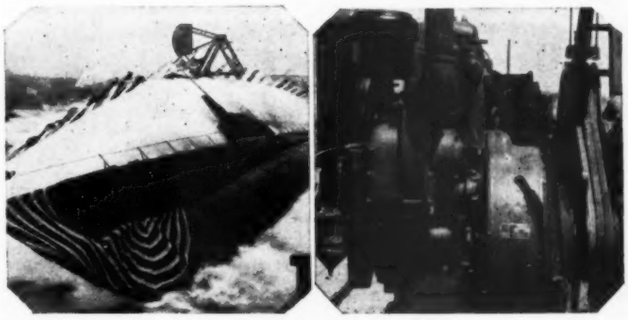
CONTROL OF TEMPERATURE, pressure, flow, and liquid level are discussed in Bulletin 87-1 issued by The Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia, Pennsylvania, who will send a copy upon request. The Brown New-Matic Time-Pattern Controller, which provides the proper time scheduling to insure continuous maximum production of finished products is described in detail.

PHOTOGRAPHS AND GRAPHS illustrate the new 12-page booklet, "Pipe Templates for Welded Fittings," which tells how to fabricate fittings for welded piping installations by means of flame-cutting and welding. An Air Reduction Company publication, it shows how to draw up and use paper templates for flame-cutting pipe to assure accurate, close fitting connections. Write G. Van Alstyne, Air Reduction Company, 60 East 42nd Street, New York City, for free copy.

From Submarines to Pumping Rigs

Rockford Clutch and Power Take-Off "known-how" and production capacity are being used by an ever increasing number of manufacturers who are serving the war program or are in essential industries. We are doing our best to keep ahead of this emergency demand for specialized

ROCKFORD *Industrial* CLUTCHES



SEND FOR THESE HANDY BULLETINS ON POWER TRANSMISSION CONTROL

Give capacities, dimensions and specifications. Contain application diagrams. Show HOW exclusive features are being used to help give post-war products competitive advantages.

Rockford Drilling Machine Division Borg-Warner Corporation

▼ ▼ 1303 Eighteenth Street, Rockford, Illinois, U. S. A. ▼ ▼

Pullmore Clutches are sold by Morse Chain Co. offices in principal cities.

You Can Trust a JENSEN

The important thing about JENSEN JACKS is the fact that so many good producers have found them less worrisome and more economical. It has been that way from coast to coast and Gulf to Great Lakes. If you want to know why, ask for Bulletin No. 27.

JENSEN

BROTHERS MFG. CO.

Coffeyville, Kansas, U. S. A.

Export Office: 50 CHURCH STREET, NEW YORK CITY

WANTED

POSTWAR

OIL INDUSTRY PRODUCT

• A Central New York Industrial Equipment Manufacturer having light steel and machine shop facilities and nationwide direct sales coverage is interested in securing a standardized item for postwar sale to the oil industry, preferably the refining branch. Box L, care of *The Petroleum Engineer*, P. O. Box 1589, Dallas 1, Texas.

MORE POWER
LESS FUEL
LONGER LIFE
by the use of
SAND-BANUM
to Automatically Keep Boilers and Tubes CLEAN

"The Entirely Different Boiler and Engine Treatment"

It removes and prevents Scale and Corrosion in absolute safety to Personnel and Equipment.

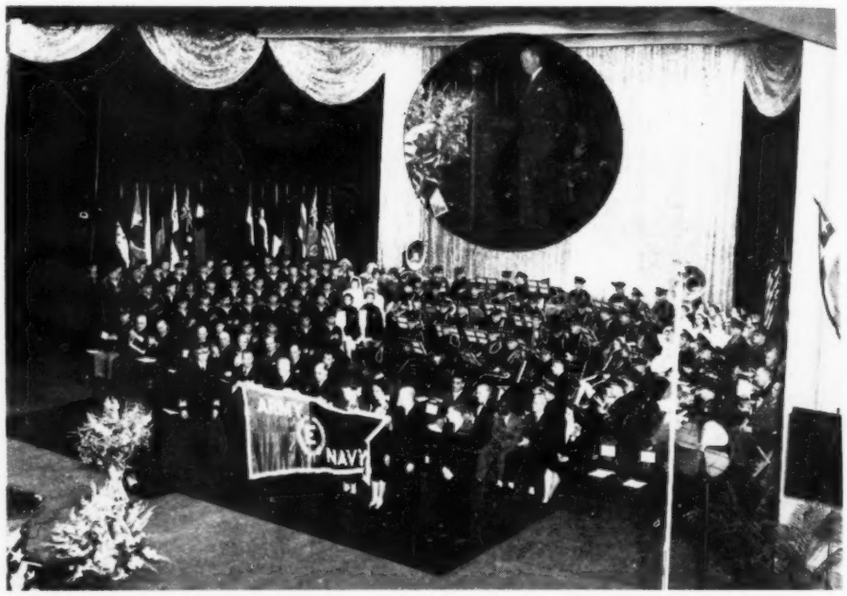
We invite you to make the test you demand at our risk.

AMERICAN SAND-BANUM COMPANY, Inc.

9 Rockefeller Plaza New York City

Army-Navy "E" Award to Wm. Powell Company

The Wm. Powell Company of Cincinnati, Ohio, has recently been awarded the Army-Navy Production Award, symbolized by the Army-Navy "E" flag and the lapel pins for every member of both plants of the company.



The accompanying photograph shows the scene on the stage of Cincinnati's largest auditorium, Music Hall, just after the presentation of the flag by Rear Admiral H. G. Taylor, C.E.C., U.S.N., and its acceptance by James Coombe, president of The Wm. Powell Company; Edward Voss, superintendent of Plant No. 1; Elmer R. Noll, vice-president and superintendent of Plant No. 2; Amelia Kramschuster, representing the women workers of Plant No. 1; Viola Tuggle, representing the women workers of Plant No. 2; William Druhman, representing the men of Plant No. 1, and August Wietlisbach, representing the men of Plant No. 2. Inset shows President Coombe making the acceptance speech.

Lieutenant Colonel Paul J. Carr, executive officer, Ft. Thomas Military Post, represented the Army in presenting the Army-Navy "E" emblems to be worn on the lapel. These were accepted by H. H. Coombe, chairman of the board; Michael Diskin, Sylvester Williams, Martha Snow, Robert St. Clair, and Edward Bootes, employees.

Made Chief Engineer

DAVID MacGREGOR

David MacGregor has been appointed chief engineer of The Edward Valve and Manufacturing Company, Inc., East Chicago, Indiana, with which company he has been associated in various engineering capacities since 1925.

MacGregor was educated in Scotland and took additional engineering work at the Illinois Institute of Technology and Purdue University.

First Woman "Serviceman"

Crews of drilling rigs around New Iberia, Louisiana, are pleasantly surprised to see an attractive young lady arrive at their lease shouldering a string of pipe protectors. She is Mrs. Ollie Burner who is taking care of Patterson-Ballagh's interests in and around New Iberia. Anxious to do her bit in the war effort while her husband, Leroy, is serving in the Navy, Mrs. Burner made a study of drilling operations and is performing a man's work.

Lufkin Foundry Honored For War Production

Lufkin Foundry and Machine Company, Lufkin, Texas, was presented with the Army-Navy Production Award at an

Left to right: Col. Merle H. Davis, W. C. Trout, Capt. G. C. McDonald, Warden Ragland, Comdr. James M. Clark, and Rear Admiral Percy W. Foote (Ret.)

impressive ceremony held June 24. The company, which manufactures carriages for guns, several types of gears, mobile laundry units, and all types of castings for the Army, Navy and Maritime Commission, is headed by Walter C. Trout; its stock is owned principally by employees.

"First 'E' Award Comes to East Texas" was the subject of an address by Hubert M. Harrison, of the East Texas Chamber of Commerce. Presentation of the award was made by Col. Merle H. Davis and accepted by Trout. Rear Admiral P. W. Foote presented the "E" pins, which were accepted by Warden Ragland, and other employee representatives were Jesse Belote, Frank Oberpriller, and Austin Johnson.

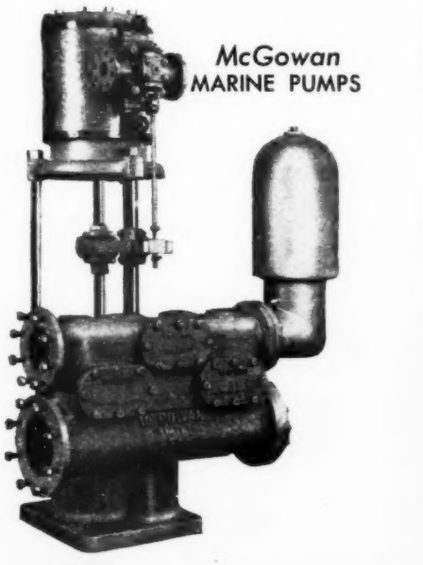
The entire program was broadcast over five radio stations. Officers of the company besides Trout are J. H. Kurth, Jr., W. W. Trout and A. E. Cudlipp, vice-presidents; W. D. Winston, Jr., secretary, and C. B. Edwards, treasurer. On the board are E. L. Kurth, L. A. Little, S. W. Henderson, Jr., and Eli Weiner.

Greenman Joins Ludlow Valve

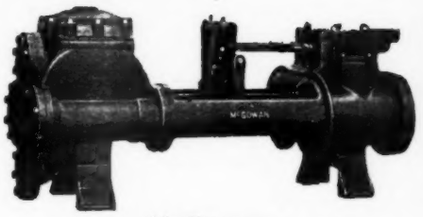
P. R. GREENMAN

P. R. Greenman has joined the Ludlow Valve Manufacturing Company as industrial sales engineer in Chicago territory.

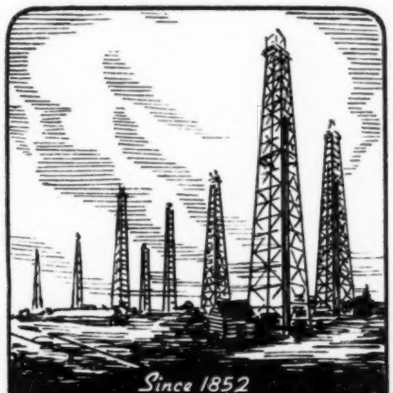
Greenman is a mechanical engineer and designer. His early work, after graduation from the University of Illinois, was as designer of valves, tools, fittings, and special machinery for the Detroit Lubricator Company and the American Valve Company. Later connections were with the Wright-Martin Aircraft Company, the Power Specialty Company, and Foster-Wheeler Company. In January, 1935, Greenman joined the Favelle-LeVally Corporation as resident engineer in Chicago, returning in July, 1937, to Foster-Wheeler, as Cincinnati district manager.



McGowan
MARINE PUMPS



McGowan
PISTON PACKED VALVE PLATE PUMPS



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for the
Petroleum Industry

DUPLEX and SIMPLEX

The McGowan Pump Division of the Leyman Manufacturing Corporation guarantees accurate workmanship and durable service. An experienced Engineering Department is available for information on installations and requirements. Highly efficient and ruggedly constructed — McGowan Pumps have the ability to stand up year in and year out under severe service conditions.

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HEAVY-DUTY AIR-COOLED

ENGINES

In today's war production set-up, even the saving of fractional manpower for servicing grease cups and oil fittings is important. And neglect of this attention can mean serious damage to irreplaceable production equipment. This can't happen with Wisconsin Engines because there are no grease cups or oil fittings; no lost manpower; no chance for human error or carelessness. Wisconsin Engines are protected by positive force-feed and splash lubrication.

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World's Largest Builders of Heavy-Duty Air-Cooled Engines

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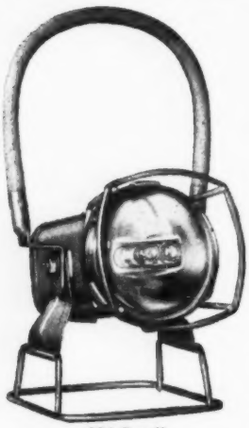
"Safety 1st" MEANS JUSTRITE'S 1st



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SAFETY CANS · FILLING CANS OILY WASTE CANS

APPROVED SAFETY ELECTRIC LANTERNS

Book Reviews

Allied's Radio Data Handbook, written and compiled by the technical staff of Allied Radio Corporation, edited by Nelson M. Cooke, Lieutenant, U.S.N. Published by Allied Radio Corporation, 833 West Jackson Boulevard, Chicago, Illinois. Pages, 48. Price, 25 cents.

Radio data has been condensed in this new book to cover all frequently used formulas, tables, and mathematical information to aid radio men. All subjects are clearly presented and conveniently arranged and cross-indexed for ready reference. There are four sections on: Mathematical Data, Radio and Electronic Formulas, Engineering and Servicing Information, and a complete set of four-place Log and Trig Tables.

The book should serve as a distinct aid to the student who is learning useful fundamentals, the serviceman who wants technical and maintenance data, the experimenter who wants monographs and practical information, and the engineer seeking a time-saving reference.

Army-Navy "E" for Parkersburg

On June 19 the Coffeyville, Kansas, plant of The Parkersburg Rig and Reel Company was awarded the Army-Navy "E" for outstanding performance in war production.

Presentation of the award was made by Rear Admiral Alex M. Charlton, I.N.M., Chicago District, and accepted by D. C. Myers, vice-president, in the presence of John M. Crawford,

Parkersburg officials with Army-Navy "E" presented to Coffeyville, Kansas, plant. From left to right, John M. Crawford, chairman of the board and president; A. G. Evans-Lombe, sales manager; A. Sidney Knowles, executive vice-president, and D. C. Myers, vice-president

chairman of the board and president; A. Sidney Knowles, executive vice-president, and William Schwemlein, general plant manager. Lt. Colonel Charles B. Harvin, Commander of the Coffeyville Army Air Base, presented the "E" pins in token to the firm's six oldest employees, who represented each of the six departments and 500 workers. They were B. M. Gott, Jesse Horrell, E. L. Brown, Carl Douglas, Mrs. Martha Sunner, and George Prather. After presentation of the pins, Ben Caudle, Jr., of the Coffeyville plant spoke in behalf of the employees.

Parkersburg is said to be the only plant in the Mid-west that has won an Army-Navy "E" from the Bureau of Ships covering both the design and manufacture of machinery for cargo and fighting ships.

MEETINGS

Kentucky Oil and Gas Association, Mid-year Meeting—July 24, Ashland, Kentucky.

California Natural Gasoline Association, Monthly Meeting—August 5, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles, California.

American Chemical Society, Petroleum Division, Fall Meeting—September 6, 7, 8, 9, and 10. Place of meeting not determined.

American Gas Association, Annual Meeting—October 11, 12, and 13, Jefferson Hotel, St. Louis, Missouri.

Petroleum Industry Electrical Association and the Petroleum Electric Supply Association—Last week in April, 1944, Dallas, Texas.

Vaupel Promoted by Cooper-Bessemer

The Cooper-Bessemer Corporation has announced the appointment of Carl H. Vaupel to the position of assistant general manager, applicable to the company's two plants, one at their Mount Vernon, Ohio, headquarters and the other at Grove City, Pennsylvania.

C. H. VAUPEL

It is pointed out that Vaupel's background makes him admirably suited for his new executive position. This is due partly to his working very closely with B. B. Williams, chairman of the board, and Gordon Lefebvre, who recently succeeded Williams as president, and due also to the wealth of experience he gained in the heavy machinery industry before joining Cooper-Bessemer in January of 1941.

Graduating from the University of Illinois in 1924, Vaupel immediately became associated with the Diesel Engine Division of Fairbanks, Morse and Company, Beloit, Wisconsin, where he worked until 1937 in various capacities in their experimental, research, and engineering departments.

Since then and until joining Cooper-Bessemer he was connected with the Northern Pump Company as eastern sales representative, and the Aircraft and Diesel Equipment Corporation as sales manager.

Since joining Cooper-Bessemer early in 1941, Vaupel has been devoting the major portion of his time to various managerial duties at the company's Grove City, Pennsylvania, plant.

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MANUFACTURERS OF Special
BOLTS, STUDS, NUTS
of high strength, heat-treated alloy steels, corrosion and heat resistant alloys, non-ferrous metals and carbon steels for refineries, natural gasoline plants and manufacturers of refinery and oil field equipment.
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Working for Victory
ENSIGN Carburetors for Natural Gas, Butane-Propane and Gasoline are playing an important part in the Victory effort. We are proud of this fact and are devoting our modern facilities and long experience to the successful completion of this assignment. Helping to win the war is our chief duty at this time.
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ON THE HOME FRONT
However, ENSIGN Carburetors for Natural Gas, Butane-Propane and Gasoline are still available for uses not directly connected with the war effort. It may take us a little longer than usual to supply the demand for carburetors, but quick delivery of emergency parts is assured.
Now, as always, ENSIGN is unequaled for efficient and economical carburation.
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Easy-to-read, raised black graduations on crack-proof white surface... resist abrasion from oil, sand, scraping on the pipe pile, etc. In all sizes and types—in cases or reels. Ask your dealer—or write for catalog.
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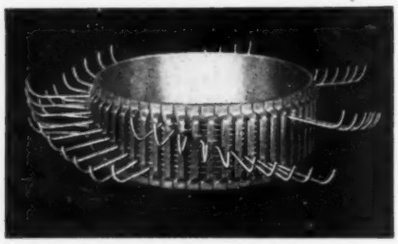
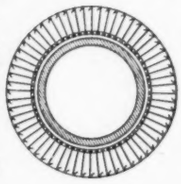
Center YOUR CASING with B and Inc. W, WALL CLEANING GUIDES



AVERAGE THICKNESS of the cement sheath around the casing in an oil well is only 1½", but even this is theoretical, because a very slight angle of inclination throws the casing off center and may reduce cement to ½"—or less—perhaps to zero!

LIKE A PENDULUM, an oil well casing is hard to sway near the top, but progressively EASIER to sway further down the hole. Thus a minor directional change near bottom will cause casing to lie against one side of the hole. **RESULT:** Faulty cementing.

THE ANSWER: The low unit cost of B and W Wall Cleaning Guides permits usage of a series of Guides carrying multiple spring wires, placed at intervals, to center the casing throughout the ENTIRE section.



IN ADDITION — and equally important — B and W Guides remove the mud filter cake from the wall of the hole just before and as the cement is placed, assuring **CONTACT** between the cement and formation.

WRITE FOR BULLETIN 102

BRUCE BARKIS — B and Inc. W, — KENNETH WRIGHT

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